Sixth Draft



July 5, 1977



# CANADA - THE NORTH - THE FUTURE

A Report by

Science Council of Canada

## SUMMARY

STATEMENT OF PERSPECTIVE: The North is a national concern and is, thus, of concern to all Canadians.

CHAPTER 1: Northern Canada is distinctively different in terms of climate, vegetation, soil characteristics and ethnic composition from urban Canada. The people of the North are literally few and usually far between. But there isn't really just one "North" in Canada, there are many Norths, for the whole area is highly diversified in its natural characteristics and in its cultural traditions.

CHAPTER 2: THE NORTH IN PERSPECTIVE. This chapter presents a brief historical review of the political economy and development of scientific knowledge of the North. An international perspective is provided through comparisons of northern areas in other countries. Some current policy issues related to science and technology are reviewed.

CHAPTER 3: STRATEGY OF MIXED DEVELOPMENT. Two historical trends are summarized. The first is towards northern development in terms of greater and greater dependence on large scale resource projects. The second is a counter-trend towards smaller scale development focused on renewable resource activity. Science Council proposes that a strategy of mixed development incorporating the best of both trends should be pursued. Although there are already activities which implicitly support the mixed strategy, there is a need for a more explicit science policy to support the strategy. This science policy will require sensitivity to traditional patterns of land use, recognition of a low biological productivity of the North and the role of public participation.

The most significant aspects of this strategy are a higher priority on local projects and the implementation of major projects only when they are demonstrably benign, both socially and environmentally.

CHAPTER 4: PRINCIPLES OF THE SCIENCE POLICY FOR NORTHERN DEVELOPMENT. Four basic principles should guide the pursuit of science policies for northern development.

1. Technological sovereignty - the ability of Canadians to control, direct and benefit from technological enterprises which affect the future of the nation. (This is a national concern).
2. Lifestyle flexibility - the need to allow opportunities for choice of lifestyle. (A local concern primarily).
3. Maintenance of the regenerative capacity of the land. (Standards of environmental acceptability).
4. Comprehensive and balanced assessment in monitoring of large and small projects. (Standards of political acceptability).

The above principles should govern the choice of all new research and development initiatives in the North.

CHAPTER 5: INITIATIVES TO SUPPORT A STRATEGY OF MIXED DEVELOPMENT. In order for the mixed strategy to be successful there must be adequate knowledge base and the communication of this knowledge as well as the education of those who will make decisions. Science Council recommends

that a "University of the North" should be established. This facility would provide a focus for the development of northern research activities explicitly designed to solve northern problems and to serve northern peoples.

The Science Council urges that universities play a greater role in solving northern problems and recommends that funds available for Canadian researchers in northern research be reallocated so that grants are emphasized over contracts. The Science Council believes that this would improve both the quality and the independence of Canadian university research in northern matters.

It is essential that a comprehensive knowledge of northern conditions and resources be developed to aid choices among development of options. Special attention should be given to the assessment of potential renewable resources in the North.

As this resource potential is understood the appropriate indigenous capabilities and the expertise necessary to develop the resources must be developed and nurtured.

To utilize the fruits of scientific knowledge, appropriate communication technologies and facilities must be made available to northern peoples and northern institutions. As well, barriers to the flow of government-sponsored technical information should be removed. The capacities of legislative bodies and individual legislators to assemble and evaluate technical information should be systematically improved.

CHAPTER 6: DIRECTION AND CONTROL OF DEVELOPMENT. A number of specific initiatives are suggested and existing institutions commented upon. Technological sovereignty can be most successfully pursued by a firm regulatory environment designed to protect new opportunities for Canadian enterprises. Crown corporations, such as PetroCan, have a potentially important role to play in enabling Canada to better control the pace and choices of technologies relevant for northern development. However, they also require a firmer regulatory policy environment.

More successful in promoting technological sovereignty is the practice of contracting out research to relevant organizations. The activities and goals of the Alberta Oil Sands Technology and Research Authority are cited as a positive example of this.

To complement technological sovereignty, there is a need for northern research development and demonstration projects as determined by local needs. Some of this research must deal with the identification and solution of existing problems in the health area, for instance. Others must be oriented towards community development projects which have as their ultimate goal economic and social self-sufficiency for northern peoples. This means an emphasis on local materials, products, labour and capital. The Science Council endorses the Federal Guidelines for Scientific Activity in the North, especially insofar as they encourage

local participation in science policy decisions and scientific activities.

The Science Council urges that large projects, as well as small ones, require an appropriate commitment to assess their feasibility, acceptability and impact. It is the size of the potential impact rather than the size of the project which is critical. The process employed by the Mackenzie Valley Pipeline Inquiry is a good example of a major component of a balanced assessment system. As a result of this and other assessments, it is now clearer that there are a number of problems, economically, environmentally, and socially, with constructing a gas pipeline for U.S. gas from Alaska through the Mackenzie Valley and there are insufficient reserves to justify a Maple Leaf line for Mackenzie Delta gas only, at this time. While some important data is still lacking as of summer, 1977, these assessments provided more information upon which to choose a route through Canada to carry Alaskan gas than was available in 1974 when the Mackenzie Valley Pipeline was first proposed. The Council recommends assessments in five other areas which it believes will contribute to the process of northern development and will enable Canada to make better use of existing and developing areas of scientific knowledge and technological expertise for the benefit of northern peoples and all of Canada.

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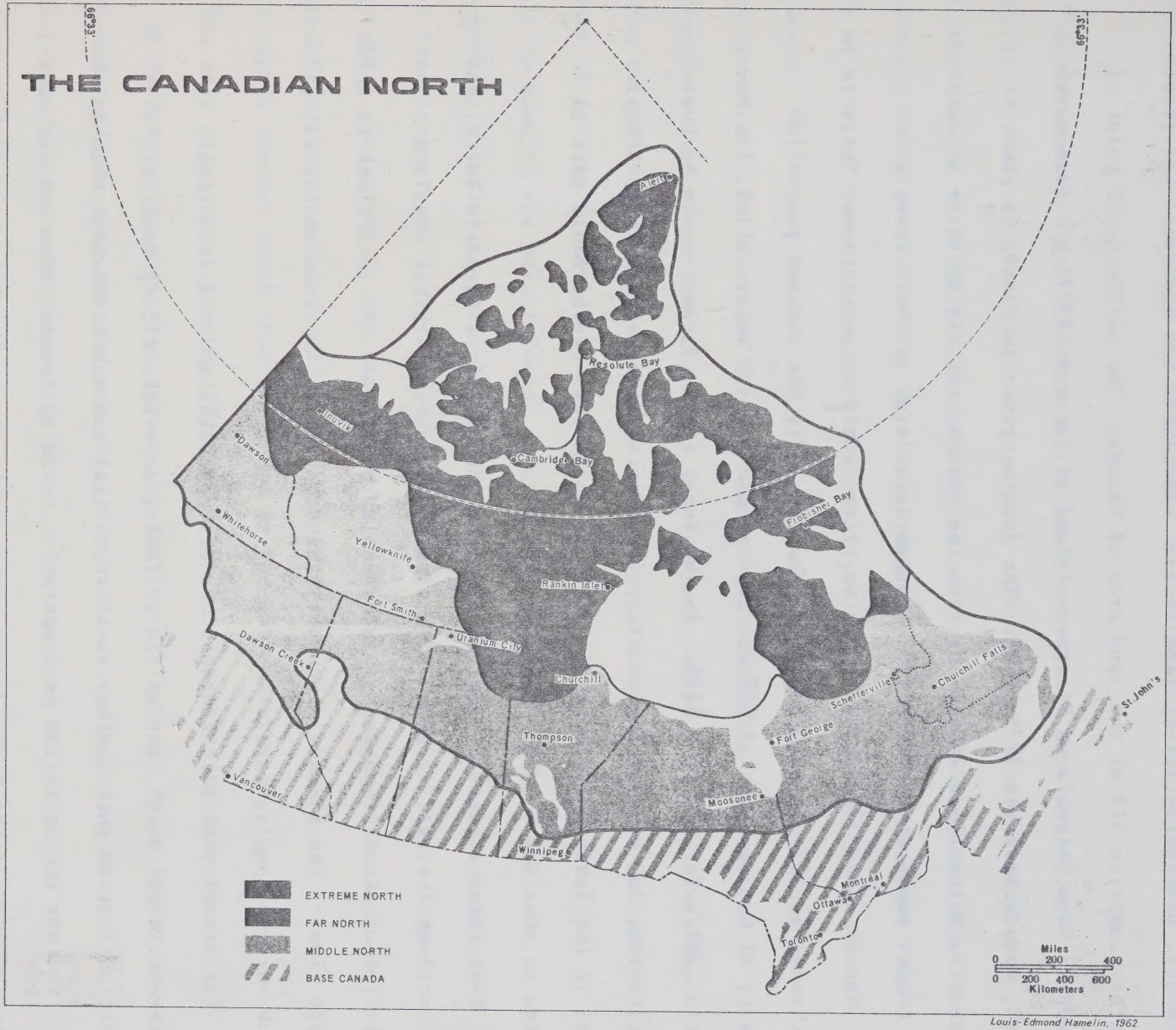
STATEMENT OF PERSPECTIVE

It's never easy to see a question from all sides at once and to achieve a comprehensive perspective. In our study of northern development we have been conscious of our several personal biases, and particularly of our essentially southern experience as Canadians. But by reading widely, by holding seminars in the North, and by striving for understanding we hope we have achieved some measure of balance.

Thus, in acknowledging our largely vicarious experience of the North, we hope that in what follows we will be seen to have recognized the challenges, the opportunities, the heartbreaks, and most of all, the future of the North and its importance to all Canadians. What we have lacked in personal background, we hope has been compensated by our interest, our empathy and our Canadianism.

Figure 1


THE CANADIAN NORTH
66°33'
66°33'
Alert
Resolute Bay
Eureka
Dawson
Cambridge Bay
Frobisher Bay
Whitehorse
Yellowknife
Rankin Inlet
Fort Smith
Uranium City
Dawson Creek
Churchill
Churchill Falls
Schefferville
St. John's
Thompson
Fort George
Vancouver
Moosonee
Winnipeg
Montréal
Ottawa
Toronto
EXTREME NORTH
FAR NORTH
MIDDLE NORTH
BASE CANADA
Miles
0 200 400
0 200 400 600
Kilometers
Louis-Edmond Hamelin, 1962

## CHAPTER ONE -- THE NORTH

Canada is the second largest northern country in the world. Farmland is 8% of Canada; productive forest land is 27%. The Yukon and Northwest Territories together comprise 41% of the land area of Canada. The northernmost point of Canada is Cape Columbia on Ellesmere Island at latitude 83°7' N. From north to south, Canada measures 2875 miles. The longest river in Canada is the Mackenzie, which flows 2635 miles from the head of the Finlay River at latitude 57° to its mouth at latitude 71°. Canada is a large northern country.

Canada ranks 33rd among countries of the world in population. There is no settlement in 89% of the area of Canada. In 1971, the average population density of Canada south of 60° was 1024 people per 100 square miles; for Nova Scotia, 3867; for Ontario, 2239. In the Yukon it was 9, and in the Northwest Territories, 3. Half of the people in the Northwest Territories and 60% of those in the Yukon are living in urban environments. The northern part of Canada is mostly a lonesome place.

Even these statistics fail to disclose the nature of Canada's North, for they reflect the artificiality of political boundaries, rather than the realities of natural geography. What really counts are the conditions in which people live -- the climate, the soil, the vegetation, the remoteness, all of which vary in complex ways.

For example, climate and soil are often thought to be distinctively different in the North, but as the following maps make clear, "northern" conditions extend much further south in central and eastern Canada than in the west, whether the criterion is temperature, growing season, snow and ice cover, or ice breakup in the spring. The tundra is to the north of latitude 69° at the

mouth of the Mackenzie River in the west, but in the east it extends south to the shore of James Bay at latitude 55° and covers a substantial portion of northern Quebec and Labrador, and almost the entire Labrador coast (Figures 2-5).

The most northern parts of the Arctic have very little precipitation. The Arctic Islands, for instance, average less than 200mm of precipitation annually, compared with the Prairies which typically receive over 400mm. The relationship among precipitation, soil temperature, incidence of permafrost, and length of growing season, is reflected in the type and distribution of vegetation. The Arctic Islands are primarily a rock desert with vegetation sparse or absent. To the south (in the now familiar line from northwest to southeast) lies an area of Arctic stony lichen-heath, which gradually gives way on Banks Island in the west and on both sides of the Hudson Strait in the east to areas of shrubby birch and grasses which, in turn, give way to a wide transition zone to the Boreal Forest stretching from the southern Yukon and upper Mackenzie Valley to part of Newfoundland, and include a large proportion of the land area of the Prairie Provinces, Ontario, and Quebec. It is often thought that conditions at the same latitude in Siberia or northern Sweden correspond to those in Canada. But the tree line in much of Canada is significantly farther south than in Sweden or the USSR (Figure 6).

The only thing about the Canadian North which is exactly the same as the north of Europe and Asia is that beyond the Arctic Circle there is at least one day when the sun doesn't set and one when it doesn't rise, an astronomical fact of great importance to those who live there. Indeed, even well south of the Arctic Circle, the long days of summer and the long nights of winter are a major fact of life in northern latitudes.

There are many ways of defining the "North". For the purposes of this study, we have chosen to use Hamelin's definition of nordicity, which draws on

Figure 2

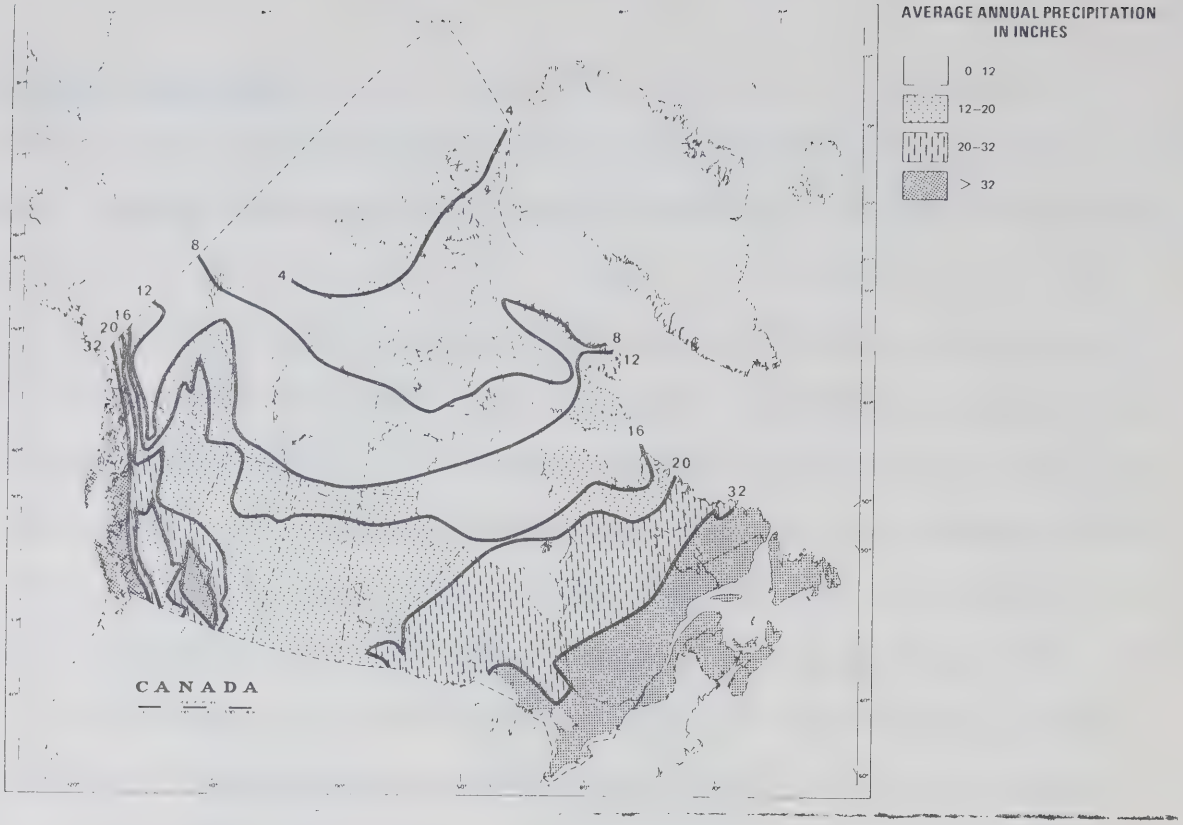



Figure 3

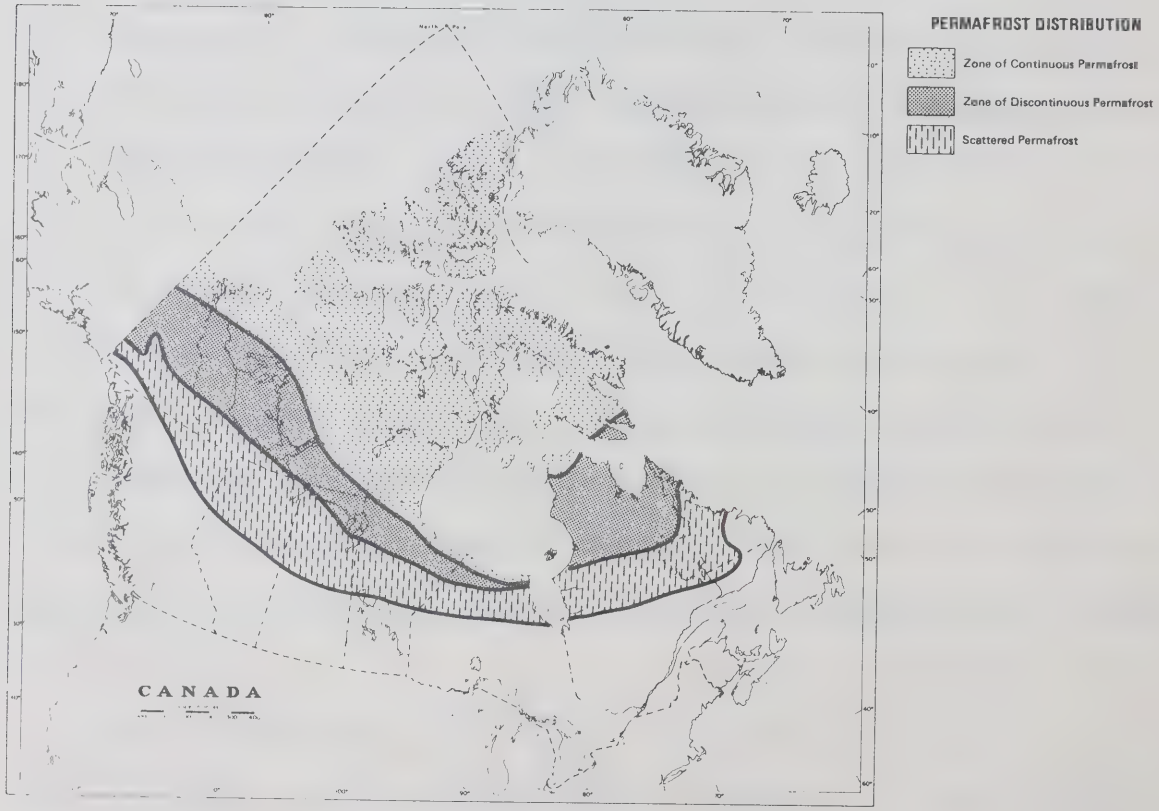


Figure 4

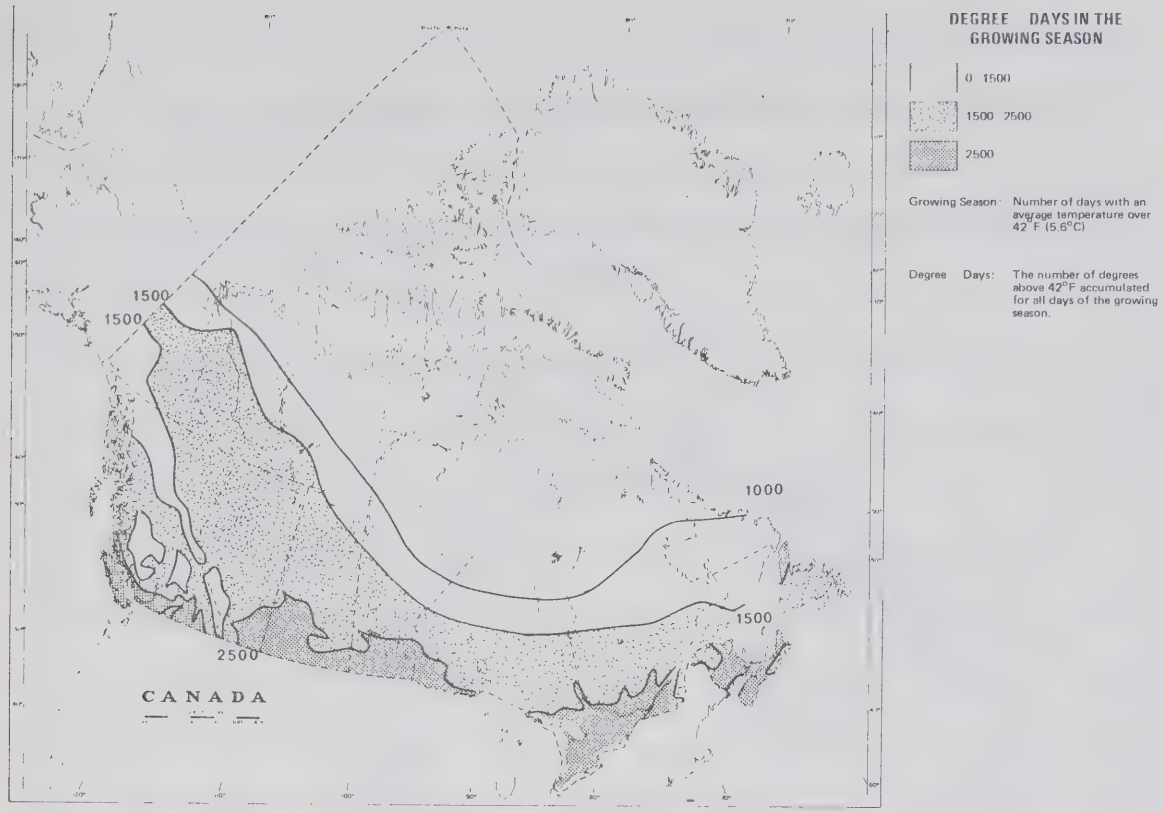



Figure 5

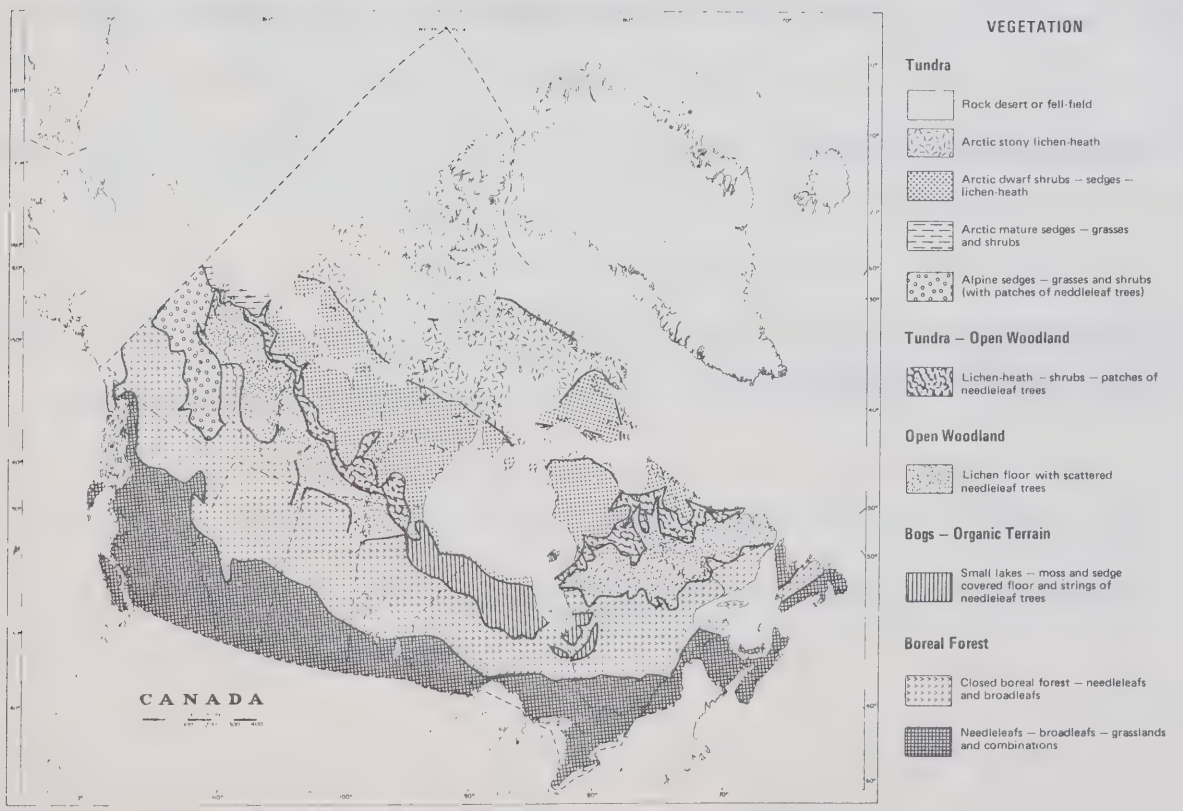
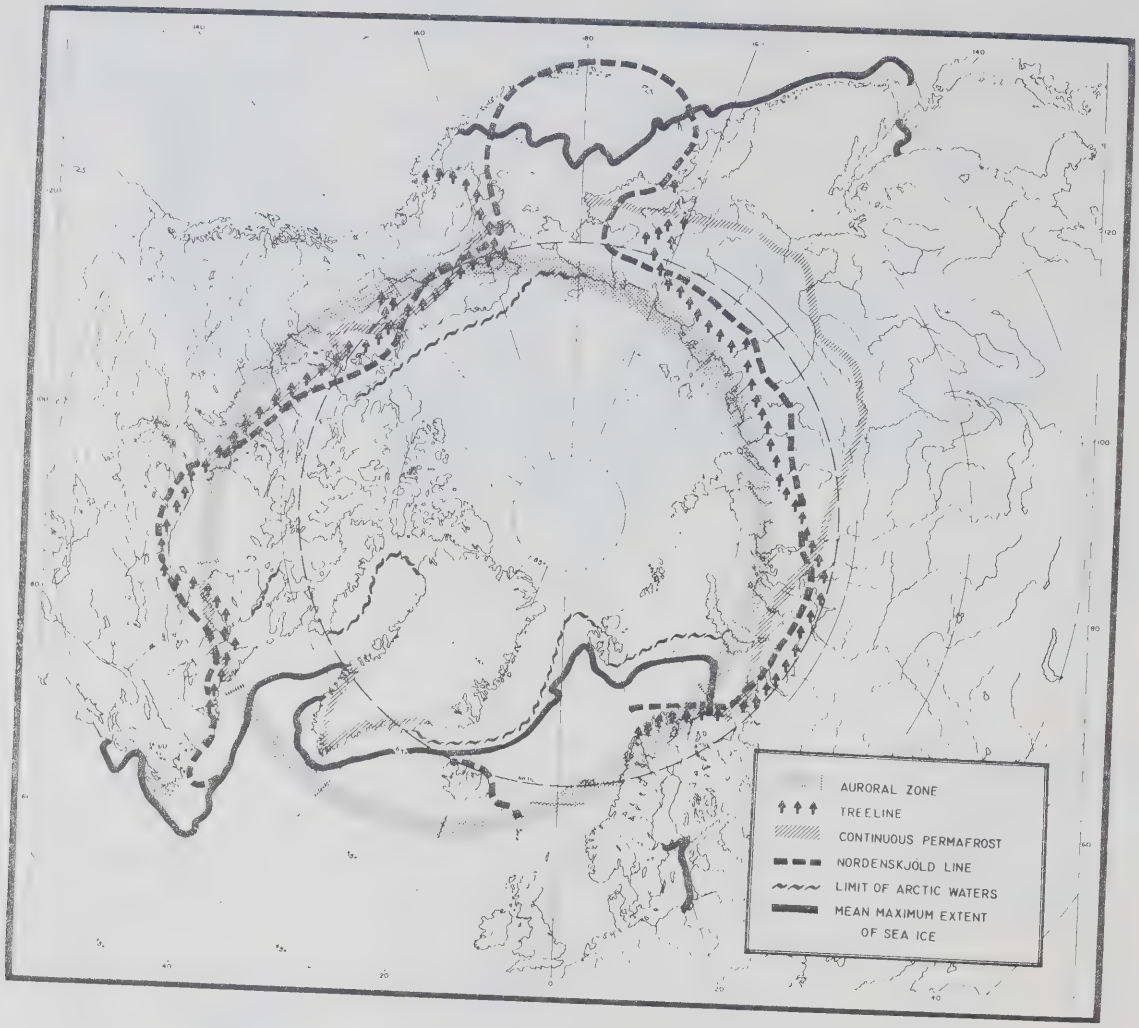


Figure 6. SOME SIGNIFICANT BOUNDARIES IN THE ARCTIC REGION




Sater, John E.; Ron Hovde, A.G.; and Van Allen, L.C.;
Arctic Environment and Resources, The Arctic Institute of North America,
1971.

10 criteria, each of which is scored on a scale of 100, to yield an aggregate index of nordicity. The North Pole has the maximum nordicity of 1000! Hamelin's criteria also imply that, as areas become more industrialized and accessible, they become less "nordic". For instance, as Hamelin has shown, Chibougamau is certainly a much less "nordic" place than it was before mining and before the associated transportation and other services became available.

The North, for this study, includes the "Extreme", "Far" and "Middle North" of Hamelin, all characterized by small populations, large distances, relative inaccessibility, a large proportion of indigenous peoples, a short growing season, permafrost, and long, cold, dark winters. The differences between the Extreme North and the Middle North are very great. The Extreme North is nearly uninhabited, has very little vegetation, continuous permafrost, ice-infested waters all or nearly all year, and very little precipitation. The Middle North has discontinuous permafrost, is heavily forested, more accessible, and is in fact where most of the resource exploitation of the North now takes place. It is the region where the large majority of northern residents now live.

The people of the North are as distinctive as the environment to which they are adapted. A northerner has northern ways. It is scarcely surprising that the North presents special problems to demographers. People move over large areas; there are cultural and linguistic differences; many settlements are relatively isolated; and the vital statistics of the northern population are accordingly more crude than for the rest of Canada.* There are, for instance, no accurate population figures on Metis and non-status Indians in Canada. The

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* c.f. The Arctic Institute of North America and the Department of Indian and Northern Affairs, Northern Population Workshops, Summary Report (Paula Weston,. ed.), May 10-12, 1976, North Hatley, Quebec

Native Council of Canada estimates 750,000 on the basis of three Metis for each status Indian, of whom there were 295,215 in the year 1971 in all of Canada.

The accompanying map (Figure 7) is the nearest approximation to the Middle, Far and Extreme North which the present-day census divisions afford. The following general characteristics emerge: the population of the North is about 1 million people; compared to the rest of Canada, people in the North are younger and slightly less well educated; and there is a larger component of native people (especially in Saskatchewan, Manitoba, Quebec, and the Northwest Territories). Much higher proportions of the population are engaged in forestry, fishing, trapping, and mining than in Canada as a whole; and much lower proportions in manufacturing, finance, insurance, and real estate. As one might expect, males outnumber females, though the ratio has been rapidly declining. In the North there are more men than women over the age of 70, whereas elsewhere in Canada the elderly are predominantly women (Table 1).

Large communities are not common in the North: in 1971, only 29% of northern residents lived in settlements over 10,000, but for Canada as a whole the figure was 65%.* Such concepts as urban or rural, however, are relative. Within the North, a settlement larger than 2000 is a comparatively urban environment. Most of the native people remain in small, relatively isolated settlements, while most northern immigrants settle in the larger centres. In the Northwest Territories, for example, 31% of the natives but over 70% of the non-natives live in the five largest communities (Yellowknife, Inuvik, Hay River, Fort Smith, and Frobisher Bay). While native northerners constitute a majority of the population in most of the area of the North, they do not constitute a majority in any major manufacturing, mining, or administrative centre.

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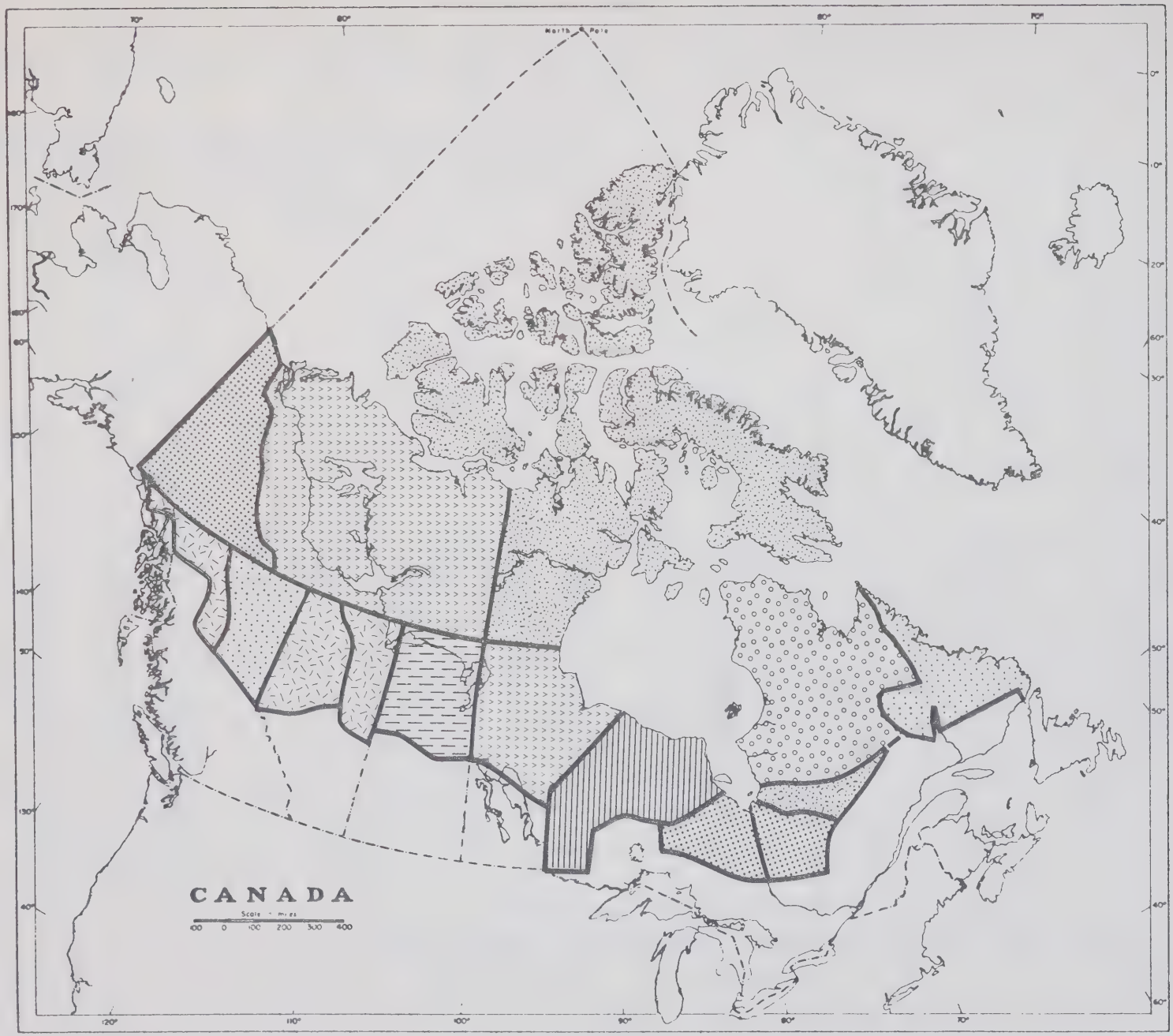
* Canadian Council on Urban and Rural Developments, "A Development Strategy for the Mid-North of Canada", Ottawa, 1976.

Figure 7




## INDIAN AND ESKIMO POPULATION, 1971

Indian and Eskimo Population as a Percentage of Total Population, 1971
By Census Division for Yukon, N.W.T. and the Northern Section of Seven Provinces.

- 1–4.9
- 5–9.9
- 10–19.9
- 20–29.9
- 30–39.9
- 40–59.9
- 60–79.9
- 80–96

TABLE 1

AGE/SEX BREAKDOWN OF THE POPULATION OF THE MID-NORTH, YUKON AND N.W.T. IN 1971

PER CENT OF THE POPULATION IN EACH AGE COHORT BY SEX

| Age Group | B.C.* | | ALTA.* | | SASK.* | | MAN.* | | ONT.* | | QUE.* | | NFLD.* | | YUKON | | NWT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. |
| 0-4 | 11.2 | 12.4 | 11.1 | 11.6 | 15.8 | 16.4 | 14.7 | 15.6 | 10.0 | 10.3 | 9.5 | 9.6 | 14.1 | 15.4 | 11.0 | 12.1 | 15.7 | 16.1 |
| 5-9 | 12.8 | 13.9 | 13.0 | 14.2 | 15.4 | 16.3 | 13.3 | 14.6 | 11.9 | 12.3 | 12.9 | 13.0 | 14.1 | 14.8 | 12.1 | 12.9 | 15.4 | 15.8 |
| 10-14 | 11.5 | 12.5 | 12.3 | 13.2 | 13.1 | 14.0 | 10.4 | 11.5 | 12.2 | 12.2 | 13.4 | 13.6 | 11.4 | 12.3 | 10.2 | 11.3 | 11.7 | 11.9 |
| 15-19 | 9.3 | 9.7 | 10.2 | 10.2 | 9.7 | 9.5 | 8.6 | 9.3 | 10.5 | 10.4 | 11.2 | 12.0 | 9.9 | 10.6 | 7.1 | 8.7 | 6.4 | 9.0 |
| 20-24 | 8.5 | 9.3 | 7.3 | 7.6 | 6.9 | 8.1 | 11.8 | 11.2 | 8.3 | 8.4 | 9.3 | 9.5 | 8.4 | 10.5 | 9.2 | 11.0 | 9.8 | 10.2 |
| 25-34 | 16.1 | 16.0 | 12.7 | 13.2 | 12.1 | 11.6 | 16.6 | 15.3 | 12.3 | 12.6 | 14.1 | 14.2 | 15.4 | 14.8 | 19.4 | 18.2 | 16.4 | 15.6 |
| 35-44 | 13.0 | 11.2 | 11.6 | 10.5 | 9.3 | 8.8 | 9.8 | 8.6 | 11.2 | 10.8 | 11.2 | 11.1 | 10.8 | 8.7 | 13.4 | 11.0 | 10.8 | 9.7 |
| 45-54 | 8.5 | 7.9 | 8.4 | 8.1 | 7.3 | 7.2 | 6.4 | 6.6 | 9.4 | 9.7 | 8.4 | 8.2 | 7.5 | 6.3 | 8.9 | 8.1 | 7.1 | 6.1 |
| 55-64 | 5.3 | 4.3 | 6.4 | 5.6 | 5.9 | 4.6 | 4.8 | 4.5 | 7.4 | 7.1 | 5.4 | 5.0 | 5.0 | 3.5 | 5.4 | 4.4 | 4.3 | 3.3 |
| 65-69 | 1.5 | 1.1 | 2.6 | 2.2 | 1.9 | 1.4 | 1.5 | 1.1 | 2.9 | 2.4 | 1.7 | 1.7 | 1.2 | 1.2 | 1.5 | .9 | 1.0 | .9 |
| 70+ | 2.2 | 1.8 | 4.3 | 3.6 | 2.7 | 2.0 | 1.9 | 1.6 | 3.9 | 3.7 | 2.3 | 2.2 | 2.2 | 1.9 | 1.8 | 1.4 | 1.2 | 1.3 |
| Sub-Total (000) | 104 | 93 | 79 | 70 | 11 | 11 | 37 | 32 | 77 | 72 | 228 | 216 | 27 | 23 | 10 | 8 | 18 | 17 |
| Grand Total | 197 | | 149 | | 22 | | 69 | | 149 | | 444 | | 51 | | 18 | | 35 | |

| TOTALS | MID-NORTH | | YUKON-NWT | | MID-NORTH, YK & NWT | | CANADA | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Sub-Total (000) | 563 | 518 | 28 | 25 | 591 | 543 | 10 795 | 10 773 |
| Grand Total | 1 081 | | 53 | | 1134 | | 21 568 | |

SOURCE: Statistics Canada Catalogue 92-772 (1971).

Table adapted from A Policy Proposal by the Canadian Council on Rural Development, A Development Strategy for the Mid-North of Canada, Appendix A, Table 2, p.112, Ottawa, 1976.

* Data refer to the northern part of the provinces.

Epidemiological data indicate clearly that health standards are low by comparison with the rest of Canada. Hospitalization rates, death rates, and most generally used indices of health indicate relatively high incidences of disease and ill health (Examples from the Northwest Territories and Manitoba are shown in Tables 2 and 3). Although the birth rate has now begun to level off, the age structure of native populations in the North resembles that of less developed countries in Latin America or Africa more than that of the rest of Canada.* (See Figure 8).

As for language, 20% of the inhabitants of the Northwest Territories speak neither English nor French. Reflecting the historical isolation of many parts of the North, there are many native dialects. In the Mackenzie River Valley and Delta, there are six native languages (Loucheaux, Hare, Slavey, Dogrib, Chipewyan and Inuktitut). The language differences, of course, are reflections of the much more profound variety of cultural traditions. The North has a mosaic of native peoples in which the distinction between Inuit (Eskimo) and native Indian is only a first and very broad distinction to which could be added a large number of others.

To summarize, Canada is a northern country. Most of the area of Canada, relatively speaking, is northern -- the North extends far south in the central part of Canada. The people of the North are literally few and usually far between. There isn't really just one North in Canada, there are many Norths, for the whole area is highly diversified in its natural characteristics and in its cultural traditions. The diversity of the North is as striking as its cold.

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* L. Auerbach and A. Gerber, Perceptions 2, Implications of the Changing Age Structure of the Canadian Population, Science Council of Canada, July, 1976, p. 11.

Chief Medical and Health Officer, Government of the Northwest Territories, Report on Health Conditions in the Northwest Territories for 1975, May 18, 1976, p.7.

# Table 2

NORTHWEST TERRITORIES

Vital Statistics - 1975

| | INDIANS 1975 Pop. - 7,678 (7,605) | | | | ESKIMOS 1975 Pop. - 14,303 (14,117) | | | | OTHERS 1975 Pop. - 16,867 (16,626) | | | | ALL GROUPS 1975 Pop. - 38,848 (38,348) | | | | ALL CANADA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | | 1974 | 1973 | 1975 | | 1974 | 1973 | 1975 | | 1974 | 1973 | 1975 | | 1974 | 1973 | 1973 |
| | No. | Rate | Rate | Rate | No. | Rate | Rate | Rate | No. | Rate | Rate | Rate | No. | Rate | Rate | Rate | Rate |
| Livebirths (a) | 198 | 26.0 | 23.6 | 26.0 | 458 | 32.4 | 28.4 | 32.8 | 540 | 32.4 | 29.3 | 34.2 | 1196 | 31.2 | 27.8 | 32.0 | 15.5 |
| Illegitimate Live Births (b) | 107 | 54.0 | 49.4 | 45.6 | 168 | 36.6 | 29.0 | 30.2 | 114 | 21.1 | 20.3 | 16.2 | 389 | 32.5 | 28.4 | 26.3 | - |
| Livebirths born in Hosps, and N/S (c) | 196 | 98.9 | 97.8 | 96.9 | 448 | 97.8 | 98.9 | 97.3 | 535 | 99.0 | 99.0 | 99.6 | 1179 | 98.5 | 98.0 | 98.3 | 99.8 |
| Low Birth Weight Infants (d) | 26 | 13.1 | 8.9 | 12.4 | 25 | 5.4 | 8.6 | 10.9 | 21 | 3.8 | 5.0 | 4.3 | 72 | 6.0 | 7.0 | 8.1 | - |
| Stillbirths (e) | 5 | 25.2 | 0 | 5.1 | 4 | 8.7 | 20.2 | 15.6 | 7 | 12.9 | 12.4 | 7.2 | 16 | 13.3 | 13.2 | 10.1 | 10.6 |
| Perinatal Deaths (f) | 13 | 64.0 | 16.8 | 25.9 | 9 | 19.4 | 49.5 | 26.8 | 10 | 18.2 | 24.6 | 12.7 | 32 | 26.4 | 33.2 | 20.2 | 17.6 |
| Neonatal Deaths (0-28 days) (g) | 8 | 40.4 | 16.8 | 20.7 | 8 | 17.4 | 40.4 | 13.4 | 5 | 9.2 | 12.4 | 5.4 | 21 | 17.5 | 23.7 | 10.9 | 10.8 |
| Post Neonatal Deaths (29-365 days) (h) | 5 | 25.2 | 28.1 | 10.3 | 14 | 30.5 | 30.3 | 31.3 | 2 | 3.7 | 6.2 | 7.2 | 21 | 17.5 | 18.9 | 16.8 | 4.8 |
| Infant Deaths (under 1 year) (i) | 13 | 65.6 | 44.9 | 31.0 | 22 | 48.0 | 70.7 | 44.7 | 7 | 12.9 | 18.7 | 12.7 | 42 | 35.1 | 42.6 | 27.7 | 15.5 |
| Total Deaths (Crude Death Rate) (j) | 53 | 6.9 | 6.2 | 5.9 | 87 | 6.1 | 6.7 | 6.1 | 57 | 3.4 | 4.5 | 5.8 | 197 | 5.1 | 5.7 | 5.9 | 7.4 |
| Deaths in Hosps. and N/S (k) | 33 | 62.2 | 65.9 | 71.4 | 46 | 52.8 | 48.9 | 57.1 | 26 | 45.6 | 58.6 | 47.3 | 105 | 53.2 | 56.0 | 55.7 | - |
| Natural Increase (l) | 145 | 19.0 | 17.4 | 20.1 | 371 | 26.2 | 21.6 | 26.6 | 483 | 29.0 | 24.7 | 28.4 | 999 | 26.0 | 22.3 | 26.1 | 8.1 |
| Maternal Deaths (m) | 0 | 0 | 0 | 0 | 1 | 21.8 | 25.5 | 0 | 0 | 0 | 0 | 0 | 1 | 8.3 | 9.5 | 0 | 1.1 |

(a) rate per 1,000 population
(b) rate per 100 live births
(c) rate per 100 live births
(d) rate per 100 live births
(e) rate per 1,000 live births
(f) stillbirths plus deaths 0-7 days per 1,000 total births (live births & stillbirths)
(g) deaths 0-28 days per 1,000 live births
(h) deaths 29-365 days per 1,000 live births
(i) deaths under 1 year per 1,000 live births
(j) crude death rate - deaths per 1,000 population
(k) rate per 100 deaths
(l) rate per 1,000 population
(m) rate per 10,000 live births

( ) Figures in brackets are "mid-year" pop.

N.B. To bring statistics into line with national compilations, rates (a) (j) and (l) have been calculated this year on the mid year calculated populations. In previous reports the end of year population has been used as a basis for calculation. Result is to elevate (slightly) calculated rates!

TABLE 3

RATES OF HOSPITAL DISCHARGE PER 1000 POPULATION FOR SELECTED DIAGNOSTIC CODE ITEMS, TREATY INDIANS AND COMPARISON POPULATIONS, MANITOBA, 1972.

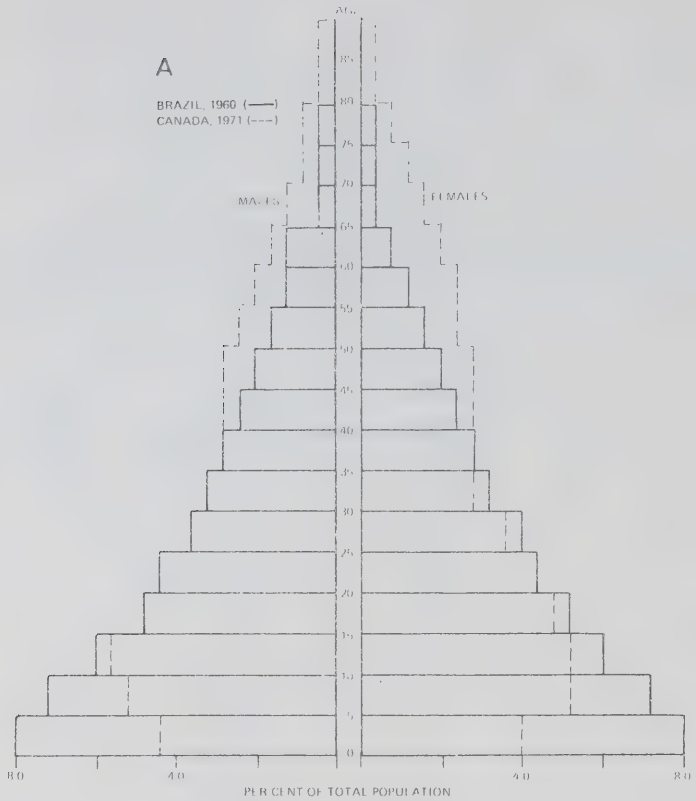
| | Manitoba Northern Treaty Indians | Northern Unorganized Territory[1] | Other Northern Manitobans | Other Manitobans |
|---|---|---|---|---|
| Intestinal Infections | 18.3 | 20.8 | 7.5 | 3.9 |
| Tuberculosis | 4.0 | 1.4 | 0.5 | 0.4 |
| Streptococeal Infections | - | - | 0.5 | 0.1 |
| Infectious Hepatitis | 0.5 | 0.7 | 0.7 | 0.2 |
| Diabetes, Mellitus | 2.8 | 2.2 | 1.6 | 1.9 |
| Nutritional Deficiency | 1.4 | 1.6 | 0.5 | 0.3 |
| Iron Deficiency Anemia | 0.1 | 0.3 | 0.1 | 0.1 |
| Mental Disorders | 7.2 | 7.6 | 8.9 | 6.9 |
| Eye Infections | 1.7 | 0.9 | 0.6 | 0.3 |
| Otitis Media | 5.3 | 4.6 | 1.4 | 0.9 |
| Acute Upper Respiratory Infections | 23.1 | 26.3 | 13.7 | 5.9 |
| Influenza | 1.2 | 4.2 | 1.4 | 1.3 |
| Pneumonia | 32.6 | 25.5 | 6.3 | 5.5 |
| Kidney Infections | 2.2 | 2.7 | 1.2 | 0.9 |
| Complications of Pregnancy | 17.5 | 12.0 | 7.0 | 3.4 |
| Complications of Delivery | 11.9 | 8.0 | 6.8 | 4.7 |
| Skin and Subcutaneous Diseases | 10.4 | 10.2 | 4.8 | 2.8 |
| Congenital Anomalies | 3.7 | 2.2 | 2.2 | 1.7 |
| Accidents, Poisonings | 36.1 | 35.8 | 28.6 | 15.9 |
| ALL DISCHARGES | 326.5 | 306.4 | 232.8 | 180.1 |

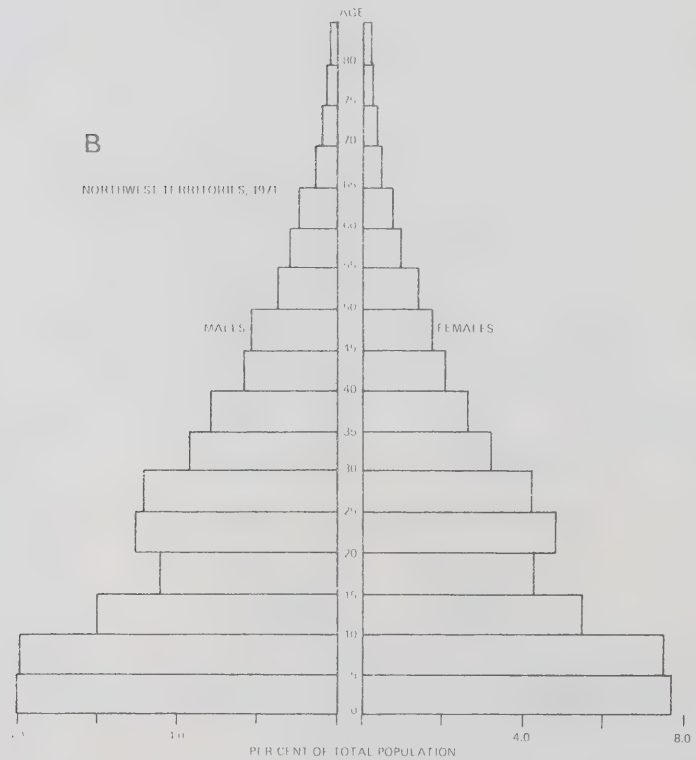
[1] Contains a large portion of Metis and non-Status Indians.

SOURCE: Manitoba Health Services Commission.

Canadian Council on Rural Development, A Development Strategy for the Mid-North of Canada, A Policy Proposal by the Canadian Council on Rural Development, Ottawa, 1976, p.33.

Figure 8




Source: Perceptions 2, Implications of a Changing Age Structure, by L. Auerbach and A. Gerber, Science Council of Canada, July 1976.

## CHAPTER TWO - DEVELOPMENT OR EXPLOITATION

### DEFINITIONS

"Development" and "exploitation" are terms frequently employed to describe activities in the North. Although these terms are often used interchangeably, it is important to distinguish between them.

Development may refer to economic, political, or social features of a country or region. It implies that change or growth in one or other of these aspects is associated with opportunities for greater internal self-determination. In contrast, exploitation refers most commonly to the economy and implies that the growth has been determined chiefly by influences external to the region.

Development in the North is preferable to exploitation of the North. Identification of the appropriate steps toward development requires an appreciation of the history of Canada's North. This chapter presents a brief historical review of the political economy and science in the North. An international perspective is provided by comparisons of northern areas in other countries and the chapter concludes with observations on some salient contemporary issues pertinent to northern development.

### HISTORICAL REVIEW

Political Economy. Fish, fur, and arctic sea mammals were the first northern Canadian resources to be commercially exploited by Europeans. Fishing off Labrador occurred in the early 16th century, and two centuries later, whaling became an important industry along the arctic coasts. In the late 19th century when whaling deteriorated, some whalers turned to trading with the native people. Their contact with the natives had a disruptive effect on the traditional economy of the eastern Arctic, because the whalers not only virtually exterminated the whale population, they also indirectly contributed to

the reduction of the wildlife resources upon which the Inuit had been subsisting. In addition, whalers introduced new diseases and the use of alcohol, both of which further stressed Inuit communities.

At the end of the 19th century, interest turned from fur trading and whaling to activities related to the burgeoning "industrial revolution". Mining, logging, and the manufacture of pulp and paper commenced. These activities broadened the resource base of the North, but while they required its resources, the activities did not depend upon the labour of the native people for their financial success.

It would appear that the essential characteristics of the North have changed little over three centuries. Until very recently, "the economy of the North was based on the exploitation of primary resources.... Consequently, economic growth has been determined by external forces, notably by demands emanating from western Europe and the rest of North America".*

World War II created a major change in activities in the North. Construction of the Canol pipeline, the Alaska highway and DEW line sites brought projects of a new, larger scale. The war itself created defense obligations which required governments to take a more active interest in the North. For both the provincial and federal governments, commercial feasibility was no longer the sole justification for Northern projects.

Since World War II, the relative levels of mineral and forest product activity in the North have been maintained, but hunting and trapping have, in general, declined. A major change has been a spectacular increase in the tertiary sector (i.e. government) in the fields of defense, health, education

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* Rea, K.J., The Political Economy of Northern Development, Science Council of Canada, Background Study No. 36, April 1976, p. 30.

and welfare services.

Today, in northern Canada, as in Alaska, there is the possibility that large resource projects such as James Bay, the Athabasca Tar Sands, or the transportation of northern gas, will have an even greater impact on northern people than the government activities of the recent past.

In summary, the present century in Canada has been characterized by a belief in growth and the necessity of resource exploitation for progress. From this perspective, the "problem" of the North is how to cope with the physical obstacles to the exploitation of resources. Canada, as a nation, is heavily dependent on foreign capital and foreign technology. Thus, it is not surprising to observe these same characteristics in the northern hinterland. Regions within a country, like nations in a global community, are interdependent, but they are similarly characterized by a strong desire for internal self-determination. The challenge of northern development is the challenge of development for all Canada.

Science. Early travellers to northern Canada wrote general geographical accounts, but the need for more complete, precise information did not occur until the late 18th century. Sir Joseph Banks visited the coasts of Labrador and Newfoundland in 1766. He subsequently became president of the Royal Society from 1778 to 1820. The era of naval exploration following the end of the Napoleonic wars was characterized by the pursuit of scientific knowledge and the Royal Society customarily nominated a scientist to take part in naval expeditions. In this way much was learned of the geography, hydrography, natural history, meteorology, and ethnography of the Canadian North.

The need for a wider approach to northern science was recognized in the First International Polar Year of 1882-3, with Canada participating

territorially. Three of the twelve stations in the polar regions were in Canada and they were established by the United States, the United Kingdom and Germany. Following Confederation, Canadian scientific efforts in the North were restricted to practical goals such as resource surveys and investigations of navigation conditions on the Hudson Bay route.

The first major Canadian scientific endeavour was the Canadian Arctic Expedition of 1913-18. Its reports on the geography, geology, natural history and Eskimos gave a comprehensive account of the area and provided a model for much of the subsequent Canadian scientific work in the North.

Between the wars, Canadian scientific work was again limited largely to geological surveys and to scientific expeditions conducted from the Hudson's Bay Company ship Nascopie. The main objectives of her annual voyages were to supply the scattered fur trading posts of the Arctic and to carry a government administrative party. The scientific work was necessarily subordinate and largely descriptive and taxonomic. Some additional research was conducted by federal scientists. Most noteworthy were field investigations and the experimental farms established near Whitehorse and at Fort Simpson. During the Second International Polar Year of 1932-3, the Canadian Meteorological service established stations at Chesterfield Inlet and Coppermine. During this time, Canadian universities played little part in northern research. Much of the scientific exploration in the North was carried out by scientists from other countries.

Northern science, like many other activities, was greatly influenced by defence projects during World War II which were on a scale far exceeding anything previously experienced in the North. The use of aircraft, which had reached into the boreal forests before the war, spread throughout the Arctic making the whole of the North more accessible. After the war, the development

of long-range aircraft combined with the destructive capability of atomic weapons was judged to be a military threat to North America. Thus the North became an area of strategic significance. Defence forces had to learn how to operate under arctic conditions, and this provided a powerful incentive for northern research. The United States was particularly sensitive to the threat of an attack launched from the northern regions and diverted some of its great scientific resources to northern problems. In Canada, the Defence Research Board organized an Arctic Research Section, built a laboratory at Fort Churchill, and initiated a series of expeditions to northern Ellesmere Island. These activities provided a focus for northern research and encouraged other government scientific agencies and Canadian universities to increase their interest in the North. Jointly with the United States Weather Bureau, five meteorological stations were established in the Queen Elizabeth Islands and were used by Canadian scientists as bases from which to carry out other scientific work. The development of several mines in the northern parts of the provinces drew attention to the resource potential of the North. The founding of the bi-national Arctic Institute of North America helped to stimulate public interest.

The nature of northern research also changed. Descriptive and taxonomic work remained important, but more effort was devoted to ecological studies, tests of equipment at low temperatures, the applications of research to northern construction, and the practical problems of living and operating in the North. During this period, the Arctic was better studied than the provincial northern hinterlands for two major reasons. The first was the lure of the Arctic, as revealed in its climate, biological productivity, and culture. The second was an administrative consideration. The federal government could direct and mobilize scientific activities more easily in the Federal North than in areas where provincial agreement was needed. In general, provinces had fewer

scientific resources than the federal government. Resource limitation also posed problems for university research. Work in the North entailed much heavier transportation and other costs than did similar research done in southern Canada. Failure to recognize these additional financial needs often meant that northern research suffered. A notable exception was McGill University, which established a sub-Arctic research station at Knob Lake on the Labrador-Quebec border and a long-term glaciological investigation on Axel Heiberg Island. Other efforts to improve the situation were made by the Department of Northern Affairs and National Resources. On the advice of the Advisory Committee on Northern Development, small annual grants to universities, specifically for northern research, were begun. These grants, which still continue, aided northern groups in a number of Canadian universities, such as the Boreal Institute at the University of Alberta, the Centre d'Etudes Nordiques at Laval University, and the Institute for Northern Studies at the University of Saskatchewan. The Advisory Committee on Northern Development also initiated the establishment of the Polar Continental Shelf project by the Department of Energy, Mines and Resources, and the creation of northern laboratories, first at Inuvik and two years ago at Igloolik, by the Department of Indian Affairs and Northern Development. The University of Saskatchewan commenced operation of its Arctic Research and Training Centre at Rankin Inlet in 1967 with the help of the Donner Canadian Foundation. In 1977, citizens of Churchill, Manitoba, founded a research station for up to 100 persons with the financial assistance of the Manitoba Communities Economic Development Fund and again the Donner Canadian Foundation.

While these measures widened the field of northern research and led to a much greater involvement of universities, the largest programs have remained those carried out by scientific agencies of the federal government. Many

factors affected the rate of growth of these agencies. Some important influences were the advent of transpolar civil aviation, the increased importance of petroleum exploration, the need for improved surface transportation, and UNESCO support for global scientific studies, as exemplified by the International Geophysical Year and the International Biological Program.

In the geophysical and related sciences, particular attention was given to meteorology and ionospheric research, geological investigations , seismic, gravity and magnetic studies, and glaciology. These studies created a need for more mapping, charting, and hydrographic information. Many of these activities occurred within the Department of Energy, Mines and Resources, but the Departments of the Environment, Communications and Transport and the National Research Council were also involved. Biological research in the Departments of the Environment and Fisheries also increased. In contrast, social research did not share in this expansion, despite the obvious need and the heavy costs involved in the administration and welfare of the native people. Annual expenditures on research on northern wildlife were and have remained much greater than research expenditures on northern people.

Within the past few years, new factors have greatly affected both the scale and nature of northern research. Intensified interest in the Athabasca Tar Sands of Alberta, petroleum exploration, and proposals for gas and oil pipelines have all spurred advances in applied research and technology. The prospect of these large-scale projects has also created concern about their impact on the northern environment and on the life of native people. This concern has prompted a great deal of short-term research directed towards answering specific questions. Unfortunately, much of this work has been of limited significance and sometimes occurred at the expense of wider-ranging research of more fundamental importance.

Activities in the North at this time also revealed difficulties in determining the scientific jurisdictions of federal departments. For example, the Department of Indian Affairs and Northern Development was charged with the promotion of commercial development of non-renewable resources, whereas the Department of the Environment was responsible for assessing the ecological impact of projects, and for protecting certain renewable resources. Partly as a result of these diverse areas of scientific activity in the North, the Advisory Committee on Northern Development convened a conference at Mont Gabriel in November 1972. Its purpose was to assess the effectiveness of northern research, determine the direction in which research would be most helpful, advise on better coordination and balance in northern research, and recommend priorities. Four years later, largely as a result of the recommendations of the conference, some general scientific guidelines for research by federal agencies were adopted by the federal government.* It is too soon to judge their effectiveness, but the guidelines indicate a desire to implement a national policy for scientific activities in northern Canada.

CIRCUMPOLAR COMPARISONS

The sub-arctic and arctic hinterlands which occur in Canada are also found in other circumpolar countries (United States, Denmark, Norway, Sweden, Finland, and the Soviet Union). The political economy of Canada's North indicates that it "has most of the characteristics of an underdeveloped country: extremely high birth rates, declining mortality rates; relatively low incomes; extreme variations in income levels from the highest to the lowest; heavy reliance on imports; little local industry; predominance of natural resource-based industry; a low level of political development, and so on".** These features, of course,

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* See Appendix One

**Rea, K.J., op. cit., p. 160.

characterize less developed areas elsewhere in Canada and can be identified in the northern hinterlands of other circumpolar countries. For the purposes of this report, the important comparisons between Canada's North and those of other countries concern the political systems, resources, and land use.

United States (Alaska). Alaska is most similar to northern Canada, particularly the Yukon. The latitude, physical features and resource base are virtually identical. In addition, Alaska's history of "colonial" status with respect to the rest of the United States, and the emergence of native peoples as a political force to negotiate land claims, are two trends which are also evident in Canada's North.

From the 1867 purchase of Alaska from Russia until World War II, trapping, sealing, mining, and fishing were all major industries "dominated by private non-resident firms and they tended to exploit resources, renewable and non-renewable, as though they were alike."* During this period, activity in Alaska was dominated by private enterprise. The federal government was involved only in a reactive manner, imposing restrictions on resource development.

World War II prompted the construction of an elaborate defence system in Alaska, and government activity in Alaska increased dramatically. The subsequent growth of the public health, education, and welfare sectors in the post-war period made government the largest growth industry. Until the recent oil boom, government was virtually the sole actor determining the growth of the Alaskan economy.

Denmark (Greenland). Greenland is a northern hinterland with no direct land connection to its mother country. This physical separation also characterizes Alaska. However, unlike Alaska, Greenland's importance for the Danish nation has not arisen from an exclusive interest in its economic value as a frontier

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*Ibid., p. 164

region. Activities in Greenland have been guided chiefly by the Danish concern for the well-being of its predominantly native population. This paternalism was reflected in a policy which emphasized social and cultural factors. It "sought to reserve whatever resource potential the area possessed for the uses of the Greenlanders themselves, the objective being to enable the population to be self-supporting at an "adequate" level of well-being through carefully regulated trade with the mother country. This trade was intended to entail neither profits nor losses for the Danish state, although in practice it appears to have been conducted at a loss."*

World War II opened Greenland to new outside influences as a consequence of a temporary period of de facto U.S. jurisdiction during the war. Large military bases and weather stations were developed and with these came an interest in a more materialistic growth. As a result, immigration to Greenland increased, and relatively large investments were made in schools, hospitals, transportation facilities, fish processing plants, and warehouses, as well as telecommunications facilities. In addition, both mining and hydrocarbon exploration were intensified.

Norway. The northern areas of Scandinavia can support more mixed farming than is possible in most of northern Canada. Although small, nomadic, native populations remain, the northern areas of Norway are characterized by problems which bear more resemblance to those of the Maritime Provinces than to those of Canada's North. Like the Maritimes, the hinterlands of Norway have not kept up with the economic development of the rest of the country. Fishing and farming still predominate. The government has tried a number of measures to assist development. Norway's attempts to induce migration to large centres through

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* Ibid., p. 172.

direct grants are similar to efforts which have occurred in Newfoundland. Norway has also made provisions for the promotion of local development projects and outright subsidization of particular industries. To date, the "oil boom" has not greatly influenced Norway's North because of a deliberate government policy limiting the exploration and development to the more southerly latitudes.

> "The basic strategy of the oil policy was to keep development under constant restraint, matching the rate of development with Norway's capacity to handle it, both industrially and socially. Although foreign companies played a very large role in this development, overall control is very much in the hands of the state, and its agency, Statoil. In the meanwhile, Norway's ship and machine builders, design engineers, and other industrialists have been able to diversify into the industry in such a way that national control and ownership is confidently maintained.
>
> "Another important lesson of the Norwegian approach is that sectors not directly benefitting from the oil-boom have not been disrupted. The fishing and small labour-intensive industries would have lost their best labour to the high wage oil industry in a full employment economy so that many small towns and coastal communities, the mainstay of Norway's existence, would have had their economic base seriously impaired. At the same time, fast development of oil would have generated enormous inflationary pressures. These considerations were taken into account, and the state not only slowed down the development rate, but also banned drilling north of 60 and put on tight monetary control, giving

Norway one of the lowest inflation rates in Europe over the past three years."*

Sweden, Finland, and the Soviet Union. These countries have all attempted to "modernize" and foster economic growth in their underdeveloped northern areas. Since the Soviet Union is the only nation that has a comprehensive and sustained policy of economic development in the arctic zones, discussion will concentrate on this country. "The conditions for plant growth are much more favourable in Siberia than at comparable latitudes in Canada. Barley, oats, rye and potatoes can be grown on a commercial scale, together with other cold crops... Thus, Siberia is quite unlike the picture most Canadians have of it. Truly Arctic conditions, or cold deserts, cover only the extreme north, that is, the Arctic Sea coastal belt and Northeast Siberia. In Canada, these conditions begin from as far south as the shores of the James Bay."**

Historically, despite a period of development using forced labour, Siberia has attracted many Slavs voluntarily. This lure is still strong for Siberia offers relatively more freedom, higher wages, wider availability of consumer goods, and faster occupational advancement than in the more settled areas. In addition, housing, cultural activities and educational facilities are relatively better than those in the rest of the USSR. Industrialization is encouraged by having the maximum value added locally. Thus Siberian enterprises customarily only export the finished materials, so that the profits and jobs are retained in

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* Hedlin-Menzies and Associates Ltd., The Role of Canadian Control of Technology in Northern Development, An Essay for Committee on Northern Development, Science Council of Canada, October 1976, p. 68-70.

**Ibid., p. 78.

Siberia. A different process occurs in Canada's North. Here the profits and most of the secondary jobs are customarily exported with the raw material.

In spite of all the government incentives for settlement and growth in northern Siberia, it still contains only 1 per cent of the USSR's total population. In the early 1960's "despite heavy inflows of labour related to oil and gas and other developments, Siberia's population declined, not only as a percentage of the USSR's but absolutely. Some oil field developments have had labour turnovers of 87 per cent."*

In summary, the experience of foreign countries in dealing with their arctic and subarctic hinterlands reveals many common features. Typically, there have been difficulties in encouraging settlement and maintaining a stable labour force. In common with Canada, the frontier activities of other nations have been shaped by the broad impact of industrialism and the need for northern resources. As these effects have been felt in the North, native peoples have tended to become more sedentary and less dominant. Economic growth in the hinterlands thus has been strongly influenced by external forces. Of all the circumpolar nations, Norway presents some exceptions to this trend. It has attempted to provide economic growth as well as some protection from the impacts of external pressures. The Norwegian policy is one of the most interesting and promising models of development.

## CONTEMPORARY TRENDS

Government and Resource Extraction. During the last 20 years, the scale and complexity of northern resource extraction has increased. With this has come increasing government involvement in the form of infra-structure support and tax

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* Rea, K.J., op. cit., p. 222.

incentives to industry. For example, at Cominco's Pine Point Mine completed in late 1966, the federal government provided a rail link from Grimshaw, Alberta, a road from the Mackenzie Highway to the mine, and a hydro power plant on the Taltson River. The railroad alone cost $86,250,000 while the Talston River installation probably cost between $9 and $10 million. Thus the government's investment in Pine Point has been quite large, while the company's investment to date amounts to $110 million. In addition, the company was exempted from taxes during its first three years, during which time it mined 50 per cent combined lead and zinc deposits and paid dividends of $47.3 million. In return, total taxes paid to the end of 1976 were $85.3 million, not including employees' income tax out of total net sales of $590 million. In addition, freight charges of $170 million were paid to the Canadian National Railway, plus $20 million towards the cost of the railway. It is therefore highly probable that, over the life of the mine, the government's investment in Pine Point will have been profitable.*

Because of the complexity of the situation and the time scale of the operation, there is a feeling among the public that the costs and benefits of such projects favour industry. The response of the federal government to this concern is exemplified by the Strathcona Mine project. Here the federal government obtained, in exchange for its support of the Strathcona Mine, not only agreement with respect to environmental regulation and employment goals, but also an 18 per cent equity in the mine. This was a significant advance, from the government's point of view, over the arrangements at Pine Point. But this agreement created some anomalous situations for the government. For

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* Private communication, J.H. Salter, Chairman and Chief Executive Officer, Pine Point Mines Limited, Vancouver, British Columbia.

example, a high ranking official from the Department of Indian Affairs and Northern Development (DIAND) sat on the Company's Board of Directors at the same time that his Department was responsible for negotiating the agreement with the company. Thus government was placed in a position of apparent conflict of interest. Since governments will probably continue to be important participants and equity holders in all major northern projects, and perhaps many smaller ones as well, this conflict of interest dilemma will likely recur.

Administration of the North and Local Autonomy. Arrangements for governing Canada's North have traditionally lodged decision and policy making power in the southern areas. For example, the Yukon and Northwest Territories are chiefly administered from Ottawa, the northern Saskatchewan area from Regina, Nouveau Quebec from Quebec City, and Labrador from St. John's. Given the south-to-north feature of administration, communication and transportation lines have also tended to run in the same direction.

Recognition of the need for more local involvement in administration and communications within the North is increasing. Increasing initiatives for local autonomy are evident in petitions to close the liquor retail outlet in Frobisher Bay, a request for a liquor quota system for the Dogrib people near Yellowknife, and the use of a referendum to achieve prohibition of alcohol in the predominantly native area of Rae-Edzo and Lac La Martre in the Northwest Territories. In this context, the comprehensive claims by native people in the North, and the James Bay settlement, are also examples of political initiatives on a broader scale.

Economy. There are statistics to support the notion that there is a dual economy in the North.* That is, there is a traditional sector which has very

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* Palmer, John, Measurement of the Value of Economic Activity in the North, DINA, April 1974.

low incomes (average per capita income, for instance, of native people in the Churchill River Study Area was $491)* and which does not benefit from modern industrial activity.

Mineral production is a sector of relatively high incomes and high profits which often exists quite separately from the surrounding area, insofar as economics are concerned. This is especially true of projects such as the Pine Point Mine or the Pointed Mountain Gas Pipeline in the NWT -- neither has had any discernible economic effects on the traditional sectors of the economy. The "dual economy" also exists in the service sector but in a different form. Although teachers, government administrators, and case workers do interact with members of the local community, their income sources and life styles are typically very different. Table 4 presents some recent general statistics on the economy of the federal North. It shows the large role of government expenditures in the Territories, greater than the total personal incomes of northern residents. Capital flows are, of course, typically from South to North.**

Technology and Culture: Health and Housing. There have been outstanding efforts to transfer the comforts and requirements of southern urban society to northern communities. These efforts have produced some undeniable benefits, such as lower infant mortality. There have also been some unintended

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* W.O. Kupsch (editor in chief), Synthesis, Prepared by Churchill River Study (Missinipe Probe), Saskatoon, 1976, p. 21.

** Palmer, John, Measurement of the Value of Economic Activity in the North, DIAND, April 1974.

TABLE 4

GENERAL STATISTICS

| | | YUKON | N W T | COMBINED |
|---|---|---|---|---|
| Area, thousand square miles | | 207 | 1,305 | 1,512 |
| Population (1976, preliminary) | | 21,392 | 42,237 | 63,629 |
| Employed (1971 census) | | 7,705 | 10,555 | 18,260 |
| Gross Personal Income (1975) | million $ | - | - | 335 |
| New Capital Investment (1975) | million $ | - | - | 422 |
| New Capital Investment (1976) | million $ | - | - | 617 |
| Electrical Power Generated, MWH | | 250,600 | 299,000 | 549,600 |
| Mineral Production (1975) | million $ | 229 | 189 | 418 |
| Mineral Production (1976) | million $ | 131 | 213 | 344 |
| Retail Sales (1975) | million $ | - | - | 93 |
| Motor Vehicle Registrations (1976) | | 13,214 | 15,350 | 28,564 |
| Average Weekly Wages/Salaries (1976) | $ | 303 | 277 | - |
| Total Federal Government Spending (1976-77) | million $ | - | - | 583 |
| Total Federal Government Spending (1977-78) | million $ | - | - | 625 |

Source: Globe & Mail: January 26, 1977, Report on Business

consequences, such as alcoholism and certain dental and ear diseases which had never been prevalent before.*

Thus, two major issues related to the design of technologies have emerged. The first is whether a new technology has a beneficial impact on the native peoples in a northern region. There are usually no clear-cut answers to this sort of question. The second major type of issue is whether the technology is sufficiently adapted to the northern physical environment. Here the inadequacy of housing or such things as snowmobile design becomes more obvious. This issue persists because, in general, the markets for northern technologies are not thought to be sufficiently attractive to warrant the expensive development work and the setting up of mass production facilities.

The issue of appropriate design for northern conditions arises less often for defense or large resource projects which carry with them enough market power to motivate improved designs of relevant technologies. As a result, a particularly visible manifestation of the "dual economy" has emerged in some northern communities in the form of different standards of housing and waste disposal provided by government and industry for their employees as contrasted to that made available to native people and long-time northern residents. There is a need to foster science and technology for the North, so that northern residents may have at hand appropriate technology to complement their chosen life style.**

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* Circumpolar Health, Proceedings of the Third International Symposium, Yellowknife, NWT, edited by Roy J. Shepherd and S. Itoh. University of Toronto Press, 1976.

**Larkin, P., "Science for the North", Science Forum, Vol. 9 No. 6, December, 1976.

Education and Culture. The extension of education to the North has also followed the pattern of good intentions and direct transfer of southern ways to the North. The subject matter and the language typically were imported without modification. The unfortunate mismatch between this educational program and the northern life style has been evident in a high dropout rate of native students. In addition, those who managed to adapt to the education offered often found that they could no longer communicate with their families. Forfeiting the northern family culture, however, did not necessarily guarantee acceptance in a southern setting. Usher* has noted that relatively few native students tend to obtain the jobs available in government and industry even though they have learned skills relevant to the new society. On the other hand, it has been argued that native people will not have the choice of entering into the economy of mainstream Canada if they are not exposed at all to the kind of education offered other Canadians.**

Recently, an awareness of the need for education to recognize cultural differences has been developing in the North and elsewhere in Canada. In the North, there are now efforts to employ the native language in schools, as well as a continuation of efforts to provide an opportunity to develop skills useful in adapting to the dominant Canadian culture.

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*Usher, P.J., The Significance of the Land to Native Northerners, Canadian Association in Support of the Native Peoples Bulletin, 17, No. 1, March 1976, p. 6.

**Council of the NWT, Priorities for the North, Tabled May 16, 1977.

THE CHALLENGE OF CANADA'S NORTH

Canada's northern frontiers have been viewed alternatively, and occasionally simultaneously, as a cornucopia of resources, an important strategic military locale, the native peoples' last refuge, a barren wasteland, and a natural laboratory for biological, physical, oceanographic, and social science.

All of these views have, at one time or another, affected the level and direction of Canada's interest in its northern hinterland. However, the vision of the North as a cornucopia of natural resources has perhaps been the most influential. Belief in the presence of large oil and gas deposits in the North has certainly motivated recent interest in the tundra, Arctic Islands, MacKenzie Delta, and off-shore Labrador. Other resources, of course, have also engendered enthusiasms from time to time. Within the last twenty years, John Diefenbaker's "Northern Vision", the optimism of the annual reports from the Department of Indian Affairs and Northern Development, and statements by those interested in promoting northern projects, created a situation in which few seriously questioned the view of the North as a storehouse of resources.

More recently, the cornucopia vision has been tempered by a growing realization of the finiteness of natural resources as well as the relative inaccessibility of the North. Thus, resources which would be extremely attractive in southern Canada are not yet economical in the North, and may not be for a long time.

The belief in a northern repository of riches has also coloured perceptions of the "problem" or challenge of the North, for it has focussed attention on the physical obstacles to resource extraction and the extension of southern-type settlement and culture. As the cornucopia vision begins to fade, the perception of the challenge also shifts. At the present time, it seems that Canadians are

becoming more aware of the essential nordicity of their nation and the need for its development. The challenge confronting Canada, including its North, is to create cohesion between the varied interdependent regions of the country while developing opportunities for regional development in the economic as well as political sense.

## CHAPTER THREE - STRATEGY OF MIXED DEVELOPMENT

The recent history of the North has been the product of two major and apparently conflicting trends. The first trend, which tends to predominate in many discussions of northern development, is based on the promise of large scale exploitation of natural resources. The second trend emerges from the history of traditional resource harvesting activities such as fishing, hunting and trapping. This trend, if followed to its logical conclusions, would result in northern development based on smaller scale projects, locally controlled

### TREND ONE: LARGE PROJECTS

The Science Council was initially of the view that the major driving force of recent activity and interest in the North was the possibility of a number of large projects. It was felt, therefore, that the technology assessment system needed for such projects deserved closer examination. Case studies were written on the following proposals or projects:*

James Bay Hydro-Electric Project

Tar Sands (Syncrude)

Mackenzie Valley Pipeline

Hydrocarbon Exploration and Development in Arctic Islands

Hydrocarbons Off-shore Labrador

Lead Zinc Mine at Strathcona Sound (Nanisivik)

These case studies represented a spectrum of the types and locations of major resource projects presently initiated or contemplated in the North. All share

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*See Preface for a list of titles and authors.

the following characteristics:

- Capital intensiveness
- Large scale
- Long lead time
- Non-renewable resource extraction (or large hydro-electric project)
- Potentially severe environmental and social consequences
- Government approval and financial support required
- Environmental and social costs that are not quantified and that are usually left out in the "go-no-go" decisions.
- Efforts to improve working conditions in the North, which is reflected in the continuing push to improve by southern standards, the amenities and living standards in the North, resulting in some attention being given to technologies related to waste disposal, housing, and health care.
- Greater attention paid to improving transportation and communications services.

TREND TWO: SMALL PROJECTS

The second trend appears quite different. It is associated with the following:

- Desire for economic self sufficiency of northern peoples.
- Desire to use skills and materials available locally.
- Concern for long term environmental protection.
- Desire for local control of education, cultural activities and municipal services, all, for instance, associated with teaching of native languages and culture.

Both trends are evident throughout the North except in areas that are completely committed to the industrial economy, or in villages that are still primarily dependent on land based resource activities for subsistence. The first trend is economically more dominant at this time but, in our view, both are important. What is needed, in the short run, is a transition to a more balanced strategy for northern development. This transition will inevitably require that a greater emphasis be placed on renewable resource management than is presently the case.

A STRATEGY OF MIXED DEVELOPMENT

The Science Council believes that both major trends described above have validity and should be accommodated in a strategy of mixed development which has two major elements. Firstly, more economic and technological self-sufficiency is required. It should be locally defined and controlled in order to counteract activities which tend to increase political and economic dependence, welfare, or other negative social conditions. This means an emphasis on relatively low capital, decentralized, and small scale, development.

The second major element is that economically viable (including social and environmental costs) large scale projects can and should take place in the North because Canada will continue to depend on energy and mineral resources for its needs, and also as a basis for export earnings of further processed materials. In this way the North can contribute to national economic and energy requirements, and build a financial basis for small scale projects which, in terms of square miles of land use, and the participation of northern peoples, should constitute a major element of northern development.

The major challenge is to develop policies and programs to implement this

strategy. Internal conflicts between large and small scale projects must be minimized and adequate means for resolving remaining conflicts must be devised. A major objective will be to encourage "parallel" development and thereby avoid physical conflict. The proposers of the Mackenzie Valley Pipeline, for instance, were aware of the enormous disruptive effects of construction on northern communities, and made several proposals which would inhibit interaction between the communities and the work camps.

The Science Council's Discussion Paper on Northern Development acknowledged that disruptive "boom-bust" effects might be minimized for mining and petroleum exploration by more extensive use of transient settlements and commuting of workers from regional centres.* In this way, some of the most disruptive social effects might be avoided while still permitting resource development to proceed in a normal way. Obviously, there are instances where a permanent settlement is desirable, such as in the Labrador City-Wabush area which has an iron ore body with an expected lifetime of more than 100 years, and which requires several thousand miners and support personnel.

The idea of transient settlements is not new. The Commission Counsel's final arguments to the Mackenzie Valley Pipeline Inquiry were also concerned with this question.** One of the strongest recommendations was related to the necessity of isolating transient pipeline workers from the community. Another recommendation was based on the observation that resource harvesting activities can be compatible with participation in wage employment. It was urged that a

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*Science Council of Canada, Issues 3, Northern Development, A Paper for Discussion, June 1976, p. 19-20.

**Mackenzie Valley Pipeline Inquiry, Commission Counsel Submissions, Oct. 1976

balance between the two kinds of activities could be achieved by wage employment schemes which are sensitive to the components of the subsistence cycle and which accommodate seasonal events like hunts, maintenance of trap lines, etc. The Science Council's Discussion Paper praised rotational schemes such as that of Panarctic Oils Limited, which allow this sort of flexibility and balance to occur.* These are examples of existing pressures and activities which implicitly support the mixed strategy which is proposed.

Purposes of the Strategy

In the past, the two elements of a strategy of mixed development have usually been in conflict. In some places this has produced social tensions and environmental degradation. Nevertheless, each trend has a discernible contribution to make to northern development. For instance, if commercial exports to southern Canada were the sole criterion, then the development of the caribou meat industry might never become viable due to high transportation costs and the cultural preferences of the majority of Canadians for beef. However, if native northerners' preference for "country foods" is acknowledged, then a recognition of the small "market" for caribou meat provides a means of utilizing the resources of the North without inflicting cultural disturbances on northern peoples. On the other hand, the capital requirements entailed in the development of northern mineral resources cannot obviously be justified simply by northern markets. Thus, there is no single pattern of development which can be applied universally in the North. The types of activities depend on the particular mix of people and resources in an area. It is necessary to seek the patterns of development appropriate to different parts

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*Issues 3, op. cit.

of the North. In this sense, the principle objectives of northern development espoused by the Science Council are similar to those expressed by the Federal Government.*

OBJECTIVES FOR NORTHERN DEVELOPMENT - THE SCIENCE COUNCIL VIEW

1. To promote the welfare of northern people, especially the indigenous peoples, through the encouragement of appropriate developments designed to aid, where the people desire this, community development, the retention of traditional life styles and cultures, as well as opportunities for participation in wage activities which support this general objective. This objective encompasses the extension of appropriate health and dental care, housing, and municipal services.

2. To maintain and enhance the regenerative capacity of the environment. This means that environmental considerations, including land use policies, will have an important role in the decision-making process for northern projects.

3. In view of this emphasis on the long term, renewable resource development should have a higher priority than at present. The goal is the economic and social sufficiency of northern communities.

4. To encourage economically viable non-renewable resource projects which are in the national interest and which will benefit, or at least not harm, northern residents and the northern environment.

In advocating such a strategy, the Science Council takes a position consistent with the announced intentions of most governments with responsibilities in the North. At present, however, the economic, social, political and science policies to support this strategy have not yet been

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*Statement by J. Chretien to Standing Committee on Indian Affairs and Northern Developmentd March 28, 1972, pp. 39-40.

effectively implemented. In particular, the Science Council believes that a balanced science policy for northern development must be established at the earliest possible time, in view of the importance of the problems which must be overcome. The aim of the Science Council thus is to assist in the creation of a policy in this context.

To the extent that a science policy for northern development has existed, it has been ad hoc, and aimed almost exclusively at supporting large scale industrial development of the North. However, recognition of the need for redressing the balance is already implicit in the activities of the Department of Indian Affairs and Northern Development in establishing its Guidelines For Scientific Activities In the North and by the Canadian Council on Rural Development in its policy recommendations for the Mid-North of Canada.* The reasons for this involve a recognition of the needs and requirements of northerners, as well as a recognition of the potential contributions which northern resources can make to the nation.

CONSEQUENCES OF A STRATEGY OF MIXED DEVELOPMENT

A strategy of mixed development is not a panacea for the automatic resolution of tensions an disagreements. It will, however, contribute to the general aim of increasing self sufficiency of northern peoples and the choices available to them. Some other anticipated consequences of pursuing this strategy include the following:

1. There will be a measurable improvement of the northern "balance of payments" problem. Insofar as the North continues to be a hinterland to the rest of Canada, there will be a natural tendency for imports to flow northward and exports to flow southward.

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* Department of Indian and Northern Affairs, Guidelines for Federal Scientific Activities in Canada's North, Ottawa, 1977 and A Development Strategy for the Mid-North of Canada, Canadian Council on Rural Development, 1976.

2. Knowledge about the environment and resources of the North will increase. In addition there will be a new orientation in research on the development of technologies which are smaller scale, less capital intensive, better adapted to northern conditions and geared to long term renewable resources.

3. Careful assessment of large projects involving the participation of all interested parties will increase.

4. Government participation in large projects will become even more common.

5. Northern communities may evolve in varied fashion according to their circumstances. Although a few settlements may remain relatively self-sufficient and isolated, there may be a trend toward regional aggregations which are socially and economically interdependent. Where inadequate resource bases exist, governments may continue supportive measures. In brief, the enormous diversity within the North will be recognized and reflected in a diversity of approaches.

6. Industry and government will accept demands for social, political and environmental accountability and, in the event of a land claim settlement, native peoples will also do so.

The most significant aspects of this strategy are the willingness to entertain local projects and to exploit the mineral resources of the North more slowly than some major actors may desire. While the Science Council does not advocate a general moratorium on major northern projects, it realizes that the goals for northern development, which the government has adopted, require consideration of many more factors than the simple attractions of the economics of exporting a non-renewable resource. The pace of northern development must depend upon sufficient scientific and technical information for assessment of

the merits of a project and the feasibility of its implementation.

The priority for local projects requires that criteria be met by large scale projects to ensure that they will not put the long-term social, environmental, and economic goals at risk. Proponents of large-scale projects should have to satisfy the authorities in open court that these criteria are met.

Meeting such criteria will require attention to social impacts. This will involve considerations such as the separation of large-scale local activities and the provision of suitable job opportunities for native peoples. It will also involve the development of technologies required to avoid ecological damage. In this sense, the development of large-scale projects therefore presents a challenge to Canadian scientists to solve particularly Canadian social, environmental, and physical problems.

In the case of the Mackenzie Valley Pipeline, for instance, it appears that currently available information* does not now justify proceeding with a

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* We say this for two reasons: The first is that proven (and more accessible) gas reserves in Alberta are 10 times greater than those in the Mackenzie Delta. At a 90% probability, likely reserves are still about 2.3 times greater in Alberta than the Mackenzie Delta. (Energy, Mines and Resources Canada, Oil and Natural Gas Resources of Canada, 1976). Since we recommend in Chapter Six that the LNG option for the Arctic Islands should be given an adequate assessment, we wish to see this option for the development of frontier petroleum resources remain open since it is likely that non-frontier gas resources can meet Canadian needs for at least the next decade. This would also allow adequate time for orderly, not episodic, development. Secondly, important information about financing, pricing, feasibility of winter construction plans, and resolution of native land claims, was not available at hearings' end.(Cont'd.)

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(Footnote Continued from 3-9)

(e.g. Mackenzie Valley Pipeline Inquiry:

Vol. 86 pp. 13013-13036, 13055-13058

Vol. 69 pp. 10339-10353

Vol. 201 pp. 31824, 31732-33

Vol. 202 pp. 32058, 31891

and National Energy Board:

pp. 3319, 31992, 29484, 6187, 1763, 32284-5, 14873, 35916, 15992, 15941, 17534-5, 33738, 14535-6, 17611-12, 24318-9, 15993, 34781)

These gaps are in addition to the negative environmental and social consequences predicted by Mr. Berger.

pipeline for gas from the Mackenzie Delta. How long the project should be delayed depends on the speed with which new information can be developed and the perceived issues resolved. The situation should be the subject of continuing review, not only in relation to evolving circumstances in the North, but also in relation to the evolution of alternative energy supplies, technologies and demand patterns.*

PERCEPTUAL SHIFTS REQUIRED

The strategy of mixed development will require a greater sensitivity to traditional patterns of land use, and a recognition of the low biological productivity of the North, which means that the land and water are used extensively, over relatively wide areas, rather than intensively, as in mining or agriculture. It is now generally accepted that "the land" has special significance for many native northerners. This means that the land must be valued not only in terms of its measurable economic values, but also in terms of its capability to meet a variety of needs which cannot be measured in terms of their monetary worth.

There must also be an increasing recognition of the value of public participation. The need for people directly affected by a project to have something to say about it is becoming more widely accepted. Disagreements now center around who should participate when, and how. In the North, the complaints about lack of adequate consultation are so frequent and numerous that the question of adequate participation has not yet become pronounced. To

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*An alternative route, such as along the Alaska Highway, might be suitable for transporting Alaskan gas to the United States. However, virtually no information was available on this alternative at the time of writing this report (May, 1977).

pursue successfully the strategy of mixed development, there must be more than informing, educating, and consulting northern peoples about the needs of the rest of Canada for a certain project. A land claim settlement may offer the possibility of a legislative basis for this participation by providing its framework, rationale, and legal forms.

## CHAPTER FOUR - PRINCIPLES OF A SCIENCE POLICY FOR NORTHERN DEVELOPMENT

Four principles should guide the pursuit of science policies for northern development. In more specific form, these principles will become performance standards against which to measure the success of demonstration programs, regulations, large projects and other initiatives. The principles are:

1. Technological sovereignty--the ability of Canadians to control, direct and benefit from technological enterprises which affect the future of the nation. (A national concern).

2. Life Style Flexibility--the need to allow opportunities for choices of life style. (A local concern, primarily).

3. Maintenance of the regenerative capacity of the land. (Standards of environmental acceptability).

4. Comprehensive and balanced assessment and monitoring of large and small projects. (Standards of political acceptability).

These principles are not peculiar to the North, but they are most germane to the successful implementation of a well balanced strategy of northern development.

As already indicated (Chapter 3), there is a need for science policy to reflect national and regional goals for northern development. To achieve this, the Science Council recommends that the above principles should govern the choice of all new research and development initiatives in the North.

### TECHNOLOGICAL SOVEREIGNTY

An obvious element of technological sovereignty is the capacity to perform certain key R&D tasks in Canada. In the Discussion Paper on Northern Development*, the Science Council Committee observed that there is in the North,

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* Issues 3, op. cit.

as elsewhere in Canada, a tendency for Canadians and Canadian science and industry to place undue emphasis on foreign expertise and foreign consultants. A clear example of this problem in connection with petroleum exploration off the Labrador coast has recently been described.*

The reasons for this state of affairs may be found in the relatively low level of industrial R&D performed in Canada and partly in the structure of Canadian industry which is largely foreign-owned. Foreign-owned firms tend to perform the research which has greatest potential for long-term payoffs in their home country.** In the case of hydrocarbon exploration offshore Labrador, some Canadian firms have participated in the data collection phase of the work, but they have had little role in the planning and design of production and transportation facilities for these resources. As a result, the nature of research activity in the Canadian resource-related industries tends to resemble the resource extraction industries themselves. That is, with a few exceptions, Canadians provide the raw materials, but the control of the operation, the processing, and long-term benefits tend to flow out of the country.

A similar situation exists with respect to construction management for large projects. Canadian Bechtel, with its experience in Churchill Falls, James Bay, and Syncrude, now has far more experience on large projects than any

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* Bruneau, A.A., "A Federal Sellout of Canadian Interests", Science Forum, Editorial, Volume 9 Number 6, December 1976, p. 2.

** Cordell, Arthur J., The Multinational Firm, Foreign Direct Investment and Canadian Science Policy, Background Study No. 22, Science Council of Canada, December 1971.

Canadian-owned firm. Their contacts with financial interests in the United States are at least as important to project backers as is their construction experience. No solely Canadian firm, or group of firms, appears to have the requisite contacts and scale of operations to undertake the large projects which are currently being proposed.

This problem persists even with smaller components of these projects, or with projects that are on a scale consistent with the capabilities of Canadian industrial and technological competence. The design of offshore Labrador production facilities and the development of ice cutting drill ships need not have been undertaken abroad except for the fact that it was not in the commercial interest of the companies involved to do this work in Canada. Even if the work was done here, canons of proprietary knowledge would prohibit it from being generally available to Canadians.

The off-shore situation has been a particular object of continuing concern. In 1973, the government announced that "Canada must develop and control within her own borders the essential elements needed to exploit off-shore resources." The basic means to achieve this end were that:

- "Canada stimulate development and effective participation of Canadian industry in the plan to see that Canada controls the essential industrial and technological ingredients to exploit off-shore resources.
- Special emphasis be given to a wide range of marine science and technology programs relating to management of marine environment, renewable and non-renewable resources, development and maintenance of ocean engineering at universities and in government laboratories and better forecasting of weather, current, ice and similar atmospheric and oceanic factors.

- Canada, within five years, achieve world-recognized excellence in operating on and below ice-covered waters.
- Canada stand equal or superior to foreign governments or large multi-national corporations in developing and maintaining a current information base about its renewable and non-renewable off-shore resources."*

In this enunciation of a Canadian oceans policy, there was indeed an expression of political sensitivity to the need for "technological sovereignty". However, the enormous amount of foreign investment needed to finance large projects can create pressures which may continue to make it difficult for Canadians to assert control over technologies which are vital to her economic health, and to the health of the industrial and scientific community. "Will one of the trade-offs for adequate levels of foreign investment in Canada's energy future be a continuation of the 300-year pattern of colonial development in Canada?"** A conscious effort will be needed to promote policies that avoid this future.

We therefore advocate the promotion of technological sovereignty as a major cornerstone of a science policy for northern development. There must be a conscious effort to support and promote research and development which will

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* "New Oceans Policy", News Release, Office of the Minister of State for Science and Technology, July 12, 1973, p. 1-2.

** Issues 3, op. cit., p. 16.

improve Canada's capacity to control and to benefit from the technologies needed to extract, process, and transport its resources. This is important not only for economic reasons, and because it will aid the health of the technical and scientific community, but also because it will be easier for Canada to control the pacing of projects so that the maximum benefits from large northern projects may accrue to Canadians.

Ownership and control are two means of attaining technological sovereignty. Other means involve attaining the appropriate political environment, organizational structures, and individual managerial skills necessary to control the relevant technologies. The examples of Norway and Japan* show that with the proper political environment, it is possible to control important technologies through appropriate licencing arrangements and/or appropriate regulatory mechanisms, provided, of course, that the nation develops and retains an indigenous capacity for innovation.

Technological sovereignty is a national concern with important regional implications. For instance, among the provinces, Alberta, Saskatchewan, and Quebec have consciously pursued policies whose primary goal is the attainment of provincial control of key technologies affecting the provinces' future.

Thus one must face the realistic probability that some provinces, as well as northern regions within the nation and within provinces, will view the pursuit of "technological sovereignty" as benefitting other areas more than their own. Their fears may be justified and therefore a major component of technological sovereignty should be a concern for regional and northern benefits, as well as for national benefits.

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* Hedlin Menzies and Associates Ltd., "The Role of Canadian Control of Technology in Northern Development", An Essay for the Committee on Northern Development, Science Council of Canada, October 1976.

Three other principles must also guide the implementation of a science policy for northern development. Careful attention to these principles will ensure that the pursuit of national technological sovereignty takes place in a manner which reflects an equally high concern for the peoples and the environment of the North.

FLEXIBLE LIFE STYLE OPTIONS

We support the first stated objective of the Federal policy for the North* which places the welfare of the northern peoples, especially indigenous peoples, as the first priority. Concern for the disappearance of their traditional way of life is not mere romanticism. It has provided a source of income, food, and satisfaction to those who pursue these activities, as well as a source of pride for Canadians who value the distinctiveness of the Canadian North. Ensuring that northerners have the option of continuing these pursuits may carry considerable social as well as long-term economic benefits. Already there are successful industrial programs which, to some extent, attribute their success to work arrangements which take into account the traditional life style of native peoples. The Panarctic Oil system of 20 days on and 10 days off is an often cited example.**

Research and development can help to preserve life style options in the North by promoting appropriate "intermediate technologies" where these seem promising. This will have implications for education and communications,

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* Statement by J. Chretien to Standing Committee on Indian Affairs and Northern Development, March 28, 1972, p. 39-40.

**Paper by Charles Hetherington at Science Council Seminar on Northern Development, January 14, 1976, Calgary.

and could ultimately alter the role of technology transfer to and from northern Canada. While technologies will continue to be adapted for use in northern environments, some may actually be developed in the North. This will require local participation in the research and in the choice of research projects in the North.

> "There are two reasons why science must be developed in the north for northerners, and to the maximum possible extent by northerners. First, it is essential that northerners know about their own regions, not only as they do now, but more systematically, in the scientific mode. Second, it is essential that northerners have their own scientists to enrich the cultural base of northern communities and to blunt the impact of the transients, partly by replacing them, partly by educating them, and partly by dominating them."*

REGENERATIVE CAPACITY OF THE LAND

The flora and fauna of northern lands and waters are not "fragile". They can regenerate if the regenerative capacity of the land is understood and respected. However, the low biological productivity of northern ecosystems means that renewable resource harvesting cannot be successfully pursued in the same manner as in southern climes. The spruce of New Brunswick are not only larger than those in the Northwest Territories, but will mature in 50 years rather than in the 100-200 estimated for the NWT. Sport fishing in the high arctic has already depleted some lakes of large char, which take 40 years

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* Larkin, Peter, Science and the North: an essay on aspirations, Science Forum, Volume 9 Number 6, December 1976, p. 21.

to reach maturity. Large fish in more southern lakes are rarely this old, because they grow to maturity more quickly. Ecological balance is more easily disturbed and less easily restored in the North.

Concern for the regenerative capacity of the land has several implications. Non-renewable projects must take the low biological productivity of the land into account when considering possible environmental impacts. As a result, projects already undertaken will require more monitoring time than that considered necessary in southern Canada.

The Science Council believes that areas should be established where no damage would be permitted, and that standards of maximum damage should be set in other areas to ensure that no long run degradation of the regenerative capacity of northern lands and waters will occur.

ADEQUATE ASSESSMENT AND MONITORING

The Science Council Study began with a concern for improving the value of science in decision-making about northern development. One question which attracted early attention was: "Is the process for assessing projects and their proposed technologies adequate?"*

The notion of a "technology assessment system" was used in attempting to answer the question. Basically this involved asking who the participants were in different projects, what their interests were, and what capacity they had for assessing the project and ensuring that it worked to their advantage. The "system" was the interactions between these "actors".

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* Issues 3, op. cit., p. 9.

It was found that:

1. There was a tendency for the interests of the major actors (i.e. government and industry) to override the interests of the other actors.
2. Northern residents tended to be excluded from the assessment system.
3. Environmental issues tended to enter only after the project was agreed upon.
4. Social issues were only narrowly defined, often in terms of job opportunities in a wage economy.
5. Economic issues were paramount, but the traditional price system and relatively short time-frame of these issues was sometimes inconsistent with long term national benefits. It has to be recognized that this reflects the fact that economic considerations, notably the cost of money, often impel major actors to take actions before an adequate data base is developed. This shows also the critical importance of the timing of the assessment process within individual projects so that the pacing of the constituent elements of northern development is an orderly one.

The Council feels that the assessment process for northern projects is an important component of northern policy. Science and technology should play an important role in these assessments. Some general principles applicable to such assessments are:

1. All affected parties must have the opportunity to participate fully in the assessment, that is, the process must be balanced.
2. Assessments must be timed so that they take place before the decision to proceed is made. (There is still the very important task of implementation and monitoring. The same criterion of balanced participation also applies here).
3. The assessment must be conducted in the context of other related projects. A single proposal, for instance, may have a relatively minor effect. However, if it is just the first of many, the cumulative effect may be much greater than

the effect of each project taken singly.

4. The assessment must have broad terms of reference. It is not enough, for instance, merely to consider whether there will be environmental effects. It must be possible for each party to determine in what ways the project may affect their interests and how, if modified, the project might have a less harmful or more beneficial impact.

5. It is the responsibility of the government to ensure that affected parties have an adequate opportunity to make their needs known and to ensure that no projects are undertaken which do not meet basic standards, economically, environmentally, and from the long range view of the most desirable rate of non-renewable resource depletion. This requires a capacity for independent data gathering and the independent assessment and evaluation of data belonging to others. The capacity for independent data gathering need not result in much duplication.

6. There must, as a general principle, be open access to information. While there are on occasion good reasons for keeping some data or plans confidential, too often this is done routinely, as a matter of course.

7. There must be independent bodies to identify areas in need of technology assessment, as well as independent bodies to conduct the assessments.

8. Where unrefereed scientific work supports a project proposal there must be opportunities for a credible validating procedure. The adversary system is useful for this, as was demonstrated at the hearings of the National Energy Board and Mackenzie Valley Pipeline Inquiry on the Mackenzie Valley Pipeline. The competing applications of Foothills and Canadian Arctic Gas produced a much more thorough examination of the pipeline proposal than if there had been only one application.

The process employed by the Mackenzie Valley Pipeline Inquiry (Berger

Commission)* has been a valuable national experience in the evolution of a balanced technology assessment system in Canada.

The Science Council urges that conscious attention be paid to these principles in the course of implementing science policies for northern development. Demonstration projects, research activities, regulations, and technological innovations which will form the substantial fruits of the policy, should be carefully measured against these principles. If they are shown to be wanting, for instance, with respect to fostering technological sovereignty, they should be amended accordingly. This will require means of defining appropriate indicators against which to measure the success of northern policy proposals and programs. This work could be undertaken, in consultation with native groups and others with northern interests, by agencies such as the Institute for Research on Public Policy, the Economic Council, Statistics Canada, the C.D. Howe Institute, a university group, or the Department of Indian Affairs and Northern Development.

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* J.J. Shepherd, "Technology Assessment in the Canadian Environment", Jurimetrics Journal, Volume 16 Number 3, 1976, pp. 167-172.

## CHAPTER FIVE - INITIATIVES TO SUPPORT A STRATEGY OF MIXED DEVELOPMENT

A science policy for northern development should aim at acquiring adequate knowledge and experience so that informed decisions can be made. These decisions will be taken by those charged with formal decision-making and also by those living in affected areas. They should be taken in view of both long run benefits and total long run costs.

For the most part, existing institutions are adequate for the tasks ahead, although some need a change in orientation. The following recommendations give general directions. Like technologies, they will have to be adapted to the distinctive conditions of different northern areas.

This section of the report suggests several initiatives which will support a science policy for northern development. Each initiative would support the strategy of mixed development, and should be implemented with particular regard to the principles for a science policy for northern development described in the previous two chapters.

### UNIVERSITY RESEARCH AND EDUCATION

#### The Role of Universities with Northern Competence

Universities should play a greater role in solving northern problems. As events in the North have progressed and work on problems related to resource extraction has proceeded, the relative role of Canadian universities in northern research and development has declined. Despite the efforts of the Universities of Alberta, Saskatchewan, McGill, Chicoutimi, Laval, Memorial and others, most northern research is now performed by industry and government. Of the research recently performed by universities, a high proportion is on contract, sometimes with restrictions on its general availability and usually without peer group reviews of the researchers or the quality of their work. Moreover, contractual arrangements have proved to be a poor base for building continuity in university

programs. Thus, the capacities of universities for independent work in the North, which were never high, have not increased.

It is important for Canada to have a cadre of university researchers in the North who are not dependent on receiving contracts from interested parties for their research money. The Science Council urges that funds available for Canadian researchers in northern research be reallocated so that grants are emphasized over contracts. The granting councils should encourage northern research by providing funds for logistic support over and above the other costs of the research. This means giving good applicants what they need to do research, and then adding what they need to do it in the North. In addition, contracting out policies of the federal government should be specially modified to ensure continuity of support for university research workers. The key words for support of university research in the North are relevance, independence, excellence, and continuity.

It is also important to stress that independence of university research should be coupled with coordination of the research efforts of the various university researchers. Even within a university, coordination between researchers can be difficult, and depends more on fertilizing initiatives than on legislating cooperation. Between universities there are even greater problems of so coordinating research work that more can be achieved jointly than separately. It is accordingly fortunate that the universities in Canada with interests in northern research have recently organized an Association, which is off to an auspicious beginning with a grant from a private foundation. Whilst it may take some time to achieve comprehensive coordination, there is good reason to believe that the Association will ensure a greater joint university effort and at the same time will provide a more effective interface between government and the university sector.

Although university researchers do not recognize political boundaries as relevant to where they do their research, it is reasonable to expect that most Canadian universities will place the greater emphasis on northern research that is in their own backyards. With the exception of Nova Scotia, New Brunswick and Prince Edward Island, all of the provinces have a local North which is a logical place for research activities, especially in the circumstances of the provincial base of their support. While many university researchers might work north of $60^{o}$, most would likely find that the costs were too great to bear. If university research in the far North is to flourish, it will take special efforts by the federal government to make it do so. The provinces will have to make an analogous kind of effort.

Northern oriented university research does not, of course, constitute the only area for university response to the needs of the North in higher education, nor, for that matter, to the needs of southern Canadians for better orientation to the northern aspects of their country. For example, in 1971-3, in Canada as a whole, only 0.8% of biology and wildlife courses, 0.0% of health science courses, and 1.1% of engineering and agriculture courses were "northern" oriented.* And, in the North, native people have consistently perceived a mismatch between the research and education which is available to them and that which they desire. The most obvious lacuna is courses in the North on biology and renewable resource management, which are commonly cited by northerners as "learning needs."

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* Koenig, Del. M. 1975. Northern People and Higher Education: Realities and Possibilities. Assoc. Univ. Coll. Canada, Ottawa. P.5. (This was Phase 2 of a project on The University and the Canadian North. The data referred to originally appeared in Phase 1, by W.O. Kupsch and Maryse Caillol.)

For the southern Canadians, the whole educational system could do with some northern perspectives; for the northern Canadians there is need for a well organized delivery system for specialized higher education.

A University of the North

A University of the North should be established. The first value of a University of the North would be to provide a focus for the development of northern research activities explicitly designed to solve northern problems. This would mean an emphasis not only on encouraging research and developing and evaluating demonstration projects, but, perhaps more importantly, an equal emphasis on extension activities -- the dissemination of knowledge and research findings to those needing them. Potentially, the university could play a key role in the implementation of a balanced science policy for northern development.

In research emphasis, the university should concentrate on areas such as resource management and the systematizing of resource inventories (as outlined in the next section of this report). It should vigorously promote the innovation of northern technologies by sponsoring demonstration projects and by helping to assess the projects of others. It should clearly be seen to be doing excellent and relevant research. Native peoples should play a central role in the choice of research topics and in the prosecution of the research. Native northerners should be given every opportunity to gain experience by working with scholars who are pre-eminent in their fields.

In its extension role, the University of the North should act as a centre for information about the North and for the North. A good library and information centre should perhaps be the first step in building a university (shades of Stephen Leacock!), and in the North it is an important first step. Resource inventories and other such data banks should be filed and maintained in

the centre. There should be easy access to other repositories of northern information. A computer linkage to other parts of Canada would be essential.

With this base of gathered knowledge, the university should launch a vigorous information service (perhaps extensively using communication satellites), and couple it with an extension program that responded to the requests of northerners for more knowledge. The university should also provide on-the-spot seminars, workshops, and extension courses, using its own faculty and perhaps faculty from southern universities when appropriate arrangements can be made.

With this kind of mission, a University of the North would have a student body comprising (1) some graduate students, largely from the south to begin with, but perhaps, with time, a growing cadre of northern students who had gone south for undergraduate training; and (2) all the people of the North who wanted specialized and reliable information of northern relevance. The first group of students would get graduate degrees, and to ensure excellence, strong liaisons should be developed with southern Canadian universities. The second group of students would in the first instance get the information they wanted, but in time there could readily develop diploma programs and perhaps, eventually, the university would develop a northern polytechnic college.

The choice of faculty members for the university would be critical, for they must combine research ability with a willingness to live year round in the North and to devote their time as much to disseminating their findings as to accumulating new knowledge. It is the sort of career that characterized the professors of an earlier generation, that built the knowledge base of the southern parts of Canada. With the right kind of faculty members, the University of the North could ensure that northern science had continuity and was not still another facet of northern development that was boom and bust.

With respect to its structure, the university should have a Board of

Governors, predominantly, if not exclusively, northerners; it should have a main campus that is a conspicuous physical presence; the existing school facilities and scientific establishments at places should be used as subsidiary campuses; the funding should be primarily from the federal government.

With a small administrative staff, a faculty of perhaps 50 professors, and a library and communications group of perhaps 50, the university could be launched for a relatively small amount of money in relation to the magnitudes of expenditures involved in northern resource development projects.

The idea of a University of the North is not new,* and there have been other visions of what form such an insitution might take. It is the Science Council's view that what is here described is most responsive to the needs of the North for the future. While a university with a graduate emphasis and an extension service without an undergraduate role may sound to traditionalists like a ham sandwich without the ham, it must be acknowledged that the northern need now is for the bread and butter of good research and good local extension work. In a less metaphorical vein, Canada has lots of good undergraduate programs in its southern universities. To duplicate them in the North would be expensive and would take a long, long time.

What is needed now is a relevant institution, with all the prestige that attaches to the word "university", and which provides a vehicle for formal communication with the intellectual resources of the rest of Canada. Few things could better serve northern aspirations as well as a University of the North. The ultimate benefit would be to Canada as a whole.

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* See e.g. Concepts Conference (University of Canada North) Inuvik, Nov. 19-22, 1971.

J. Lotz, Northern Realities, Toronto New Press, 1970, pp. 238-248.

Arctic Institute of North America, Education in the Canadian North - Three Reports 1971-1972, Montreal, 1973.

## KNOWLEDGE AND RESEARCH BASE FOR THE STRATEGY OF MIXED DEVELOPMENT

### An Adequate Data Base

To aid choices among development options, comprehensive knowledge of northern conditions and resources must be developed. Special attention should be given to the assessment of the potential of renewable resources.

For information to be useful, it must be accessible and relevant to its intended purposes. Our case studies pointed to great problems in this area. Critical information was often not available when needed, so that "crash" programs had to be mounted. The question of pacing is also paramount. Deliberate and steady accumulation of knowledge is preferable to crash programs, especially in view of the variability of northern conditions, particularly climate, soil, and population dynamics. Given the shortage of scientific resources and facilities, research has tended to concentrate in areas having, or about to have, major large projects. Research in other areas is spotty. While we do not criticize the strategic approach to northern research, there are too many areas where too little research is done.

One of the major tasks of the proposed University of the North could well be to help overcome the episodic and spotty nature of much northern research. A university located in the North could be better suited to initiate and conduct major research programs on a continuing basis and with representative geographical coverage than universities in Southern Canada which are not focussed on northern research themes. The communication network we foresee for the North will be the tool by which the new university can monitor and aid research by being conducted anywhere in this vast region.

Basically two kinds of data bases, which in practice overlap, are necessary. The first is data at a general level which permit policy decisions, and the second is the kind of detailed information which is necessary for a

project to be implemented.

Lack of information can be expensive and disruptive. For instance, without having carefully studied the environmental impact of tailings disposal into Strathcona Sound, Mineral Resources International Ltd. set up its concentrator and townsite at locations which were unsuitable from an environmental viewpoint. Our case studies tell of similar situations with respect to James Bay and the Syncrude project. If important environmental information had been known and designed for earlier in the process, significant savings could have been made later. A process of decision-making which had admitted environmental factors into the process at an earlier stage would probably have avoided such errors.

It is important, therefore, to distinguish between research which provides the information to permit a choice between policies, and research which supports a policy already chosen. All too often, research which supports a policy already chosen is presented as research which will aid in the decision of whether or not a specific project which supports that policy should proceed.

To pursue the mixed strategy successfully, knowledge of both the renewable and non-renewable resource potentials is important. Inadequate knowledge can lead to decisions which reflect an unbalanced data base. We recognize that it will not always be possible, given the size of the North, to have a completely satisfactory data base. Decisions to proceed or not will inevitably rest on incomplete facts.

The Existing Data Base for Non-Renewable Resources and Hydro Electric Projects

In general, there is now more detailed knowledge of non-renewable resource potentials than there is of renewable resource potentials. As far as minerals are concerned, large areas of the North have already had systematic geological, geophysical, and geochemical surveys. Although such survey techniques can and

ought to continue to improve, the data base for mining is reasonably good. There are a number of undeveloped deposits, particularly of uranium and lead-zinc, which await only a favorable political and financial climate.

A similar situation exists with respect to hydrocarbons. Techniques are relatively well developed and although canons of proprietary knowledge restrict detailed public knowledge of the extent of recent hydrocarbon discoveries, it is known that the most likely areas of future frontier development lie in the Arctic Islands, in the Beaufort Sea and, to a lesser degree of certainty, in off-shore Labrador. More exploratory work will have to be done before it can be decided whether these areas have potential for commercial production.

With respect to hydro-electric projects, information is sparser. While there is sufficient data to indicate how much hydro potential exists in the North, much less is known about the engineering practicability, availability of storage sites, or economic viability of the sites. Of the total theoretical potential (16,400 MW (at 0.6 capacity) in the Yukon and NWT), 0.4% has been studied to a pre-feasibility level.* Given the limited population of the North, this may be sufficient for many years to come, except in areas where mineral extraction is contemplated.

In sum, while there are some problems with respect to data on resource potentials for non-renewable mineral extraction and for hydro-electric projects, research in these areas should more profitably concentrate on aspects of extraction, production, transportation and the attendant social and environmental impacts. We shall return to this point below.

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* W.J. Smith - "Hydro" - Presentation to the 7th National Northern Development Conference, Edmonton, Nov. 3, 1976.

Data for Smaller Projects

With respect to renewable small scale resource potentials, the data situation is more serious, despite a few efforts presently underway to redress the balance. The major resources are fish, game, agricultural products and forestry products.

Some numerical estimates of past levels of resource harvesting can be derived from records of the Hudson's Bay Company and provincial and territorial government departments. However, this knowledge is rarely systematic, and due to wide fluctuations in populations and habitats, surveys taken in one year are not always useful the next. In the Northwest Territories, the Arctic Land Use Research Program and the Inuit Tapirisat of Canada have made good progress in mapping the general locations of game and fish populations. However, the data for accurately determining sustainable yields is lacking in many instances, such as for the salmon fishery off the Labrador coast as well as the fish in the Mackenzie River. Nevertheless, estimates have been made which show that while the land is being well used (in fact, in some areas there would be over-harvesting without regulatory controls), there are many significantly underutilized species including arctic fox, caribou, musk-oxen, reindeer, ring seal, white whale, char, whitefish, beaver, various bird species, lynx, wolverine, and edible plants and berries.* As with all resources of the North, access to the resource is often a major impediment, but it is not the only one.

There is also a need for adequate inventories of many species, improved knowledge of food chains and ecological relationships, and research and demonstration projects on new systems of marketing and price supports. While a

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* J.G. Nelson, Summary and Recommendations, Renewable Resource Project, Vol. II, Inuit Tapirisat of Canada, July 1975.

few projects have been initiated and have enjoyed some limited success, "these schemes have usually been undertaken without adequate funding and always without a clear acknowledgement that the native people should run these ventures themselves.*

Agriculture

With respect to agriculture and animal husbandry, it has been estimated that there are 4.8 million acres of potentially arable land in the NWT and Yukon.** Although the potential land area is vast, almost all of it is of marginal utility compared with the productive potential of more southerly agricultural lands. At one time, when transportation was more difficult and transportation costs were higher, gardening and animal husbandry were commonly pursued by missionaries and other northern residents of European stock. Despite increased populations, agricultural pursuits are now much less common in the North, as relative transportation costs have declined. Among native people, store-bought foods have become a major dietary source, especially in the larger settlements with large non-native populations. However, apart from market gardening, the Department of Indian and Northern Affairs no longer issues land use permits for agriculture, in order to allow the completion of a soil survey which is designed to permit sharper delineation of the most suitable agricultural areas of the NWT.***

Forestry

Similar comments can be made about forest resources. At a general level,

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* T. Berger, Northern Frontier, Northern Homeland, Vol. I, Ottawa, 1977, p. 185.

** W. Pringle, "North of the 60th", Agrologist, Nov.-Dec. 1974, p. 4.

*** Department of Indian and Northern Affairs, "Temporary Suspension of Disposition of Federal Crown Lands for Agricultural Uses in Yukon and Northwest Territories", Communique 1-7460, Yellowknife, Jan. 10, 1975.

it is known that the wood resources of the North are large. However, many stands are comparatively inaccessible to commerical markets, might take a century or more, if they regenerate, and are of marginal quality for lumber uses. Nevertheless, while perhaps not suitable for large-scale commercial exploitation, they can serve the needs of local populations.

Renewable Resource Inventories Need Special Attention

The data base for resource potentials, while not perfect, is adequate for assessing large projects and ought to become adequate for assessing the potential of smaller projects as well. However, the situation is even less satisfactory with respect to project implementation or evaluating interactions between competing land uses. Once the potential of a resource has been established, it can quickly become evident that the knowledge necessary to develop the resource successfully may not yet exist. It is equally obvious that without adequate data bases, it is impossible to make reliable financial, engineering, environmental, or social predictions with respect to northern activities.

Because of the size of the North and its relative inaccessibility, data have proved to be a particular problem in northern science, and the Science Council has often discussed it. A report on fisheries and wildlife research in Canada expressed concern that ecological and environmental research might not receive adequate attention in the push to develop Arctic resources. We urged, therefore, that the first priority in environmental research be given to renewable resource inventories, that ecosystem studies be extended, and that research on industrial impacts upon Arctic renewable resources be instigated.*

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* Science Council of Canada, Report No. 9, This Land is Their Land - A Report on Fisheries and Wildlife Research in Canada, October, 1970.

These basic recommendations remain applicable today. There is still a need for an inventory of most renewable resources, especially those with little obvious commercial attraction.* It is important to realize that inventories cannot be taken only in one year and in one place, because many northern species fluctuate widely in numbers, and there are also wide variations in soil and vegetative conditions.

An important objective of an inventory should include the establishment of potential sustainable yields of several resources from a region. Accordingly, the inventories cannot be conducted or considered in isolation from each other. For example, with regard to inventories of potentially arable land, it will be necessary to consider alternative renewable resource uses, such as trapping or logging, and the long-term effects of one pattern of resource use on another. With respect to forests in the NWT, their potential is entirely theoretical, because it is not known what would happen if large areas of the North were completely logged over. There has been speculation that this would extend the tundra, negatively affect wildlife populations, and so on. Therefore inventories of renewable northern resources should take into account alternative patterns of renewable resource development and their possible impacts on each other. Modelling and simulation studies will be useful methodologies.

Data for Decisions

Another reason for an adequate data base is the need for sufficient baseline data to assess the impacts of large scale resource exploitation before making decisions to proceed. The Science Council made this point in 1973 and it is still valid.

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*Since the publication of Report No. 9, IBP has completed a study, (headed by Dr. L. Bliss of the University of Alberta), of biological productivity of a tundra ecosystem on Devon Island.

"During the past two or three years we have become aware that our knowledge of the North is inadequate - inadequate, that is, to formulate an integrated development plan for that vast region of Canada. Crash programs to collect badly needed information, often after development decisions have been made, will neither relieve the knowledge deficiency nor provide strong foundations for a sound development policy (which, interestingly, would still be unimpeded by the jurisdictional problems that beset the rest of Canada). A sustained, organized research effort is badly needed."*

There is a further, related need for an adequate data base. The governments responsible for administering and regulating northern development have responsibility for a bewildering variety of legislation and regulations. While these regulations can and, in some cases, should be criticised, it is more often the case that the data base and available manpower are inadequate for the task.

For example, almost no base exists for the administration of the Arctic Water Pollution Prevention Act. The data base for the administration of environmental protection legislation, such as the Northern Inland Waters Act or the Territorial Land Use Regulations, is often lacking as well. This is doubly unfortunate in view of the insufficient and often inadequately trained manpower for the day-to-day administration of these measures.

Summary

The existing data base reflects the de facto northern science policy of the past. There is, therefore, some general data about resources with commercial

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* Science Council of Canada, Report No. 19: Natural Resource Policy Issues in Canada, January 1973, p.38-39

potential. However, there are gaps in the specific knowledge required to extract these resources, especially in areas which are relatively less accessible and therefore less profitable. It is for this reason that both the Federal and Provincial governments have devised various means of encouraging further hydrocarbon and mineral exploration in frontier areas. In general, little is known about the potentials of renewable resources, with the possible exception of a few large mammals. Even less is known about the relationships between different kinds of resource development. What are the effects of logging on hunting, of mining on fishing, of farming on tourism, of tourism on northern residents?

The Science Council recognizes that it is not feasible to have a "complete" data base ready at all times for all purposes.

What is needed, as much as improvements in the data base itself, are:

1. The capacity to obtain a data base when needed.
2. Sufficient time to obtain the data base to ensure an adequate understanding of the environment.
3. Ready access to the data base.

There will often be pressing reasons why time is not allowed to compile enough base-line information. In such cases, extreme conservatism is needed in setting allowable catches, length of drilling season, and so on. A further reason for conservatism is that the prospect of increasingly variable, and perhaps colder, climate will have negative impacts on both biological productivity and Arctic navigation. It will be necessary to allow for this contingency in setting standards and allowable limits.

DEVELOPMENT OF APPROPRIATE EXPERTISE AND TECHNOLOGIES

Appropriate northern technological capabilities and the indigenous expertise necessary to utilize this capability must be developed and nurtured.

The inventories, resource data bases, and other basic information discussed in the previous section are not ends in themselves, but are essential ingredients in advancing northern development. Having acquired the data, the next stage is developing the ability to process and use it. Our case studies indicated that not only are there important gaps, but that some of the participants in northern development, notably native peoples and northern residents, do not have the same level and quality of research resources as industry and government. Canada, as a nation, must also develop a capacity for addressing northern problems with an appropriate level of knowledge, ability and physical facilities.

Insofar as Canada's North is concerned, the Science Council has for many years been calling for improved efforts related to earth sciences, forestry, fisheries and wildlife, energy, and oceans science.

Others have expressed similar concerns. According to scientists, industrialists, and northern residents, many areas need further attention. These have been comprehensively described at the Mont Gabriel conference*, the St. John's** conference, and at the Mackenzie Valley Pipeline Inquiry.*** There are many other documents which also make relevant northern science policy recommendations which the interested reader may wish to consult.****

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* K. Greenaway (ed.), Science and the North, Ottawa, 1973.

** NATO, Arctic Systems Conference, St. John's, 1975.

*** Berger, T., Northern Frontier, Northern Homeland, Ottawa, 1977 (and the evidence).

****e.g. 1.Pimlott, D., Vincent, K., McKnight, C., (ed.), Arctic Alternatives, Canadian Arctic Resources Committee, 1973.

Much of the above expertise, particularly that related to inventories and environmental matters, resides with industry, both in and outside Canada. In his report, Justice Berger proposed that government "must have an independent body of knowledge" in order to intelligently assess industry proposals for facilities such as laying pipelines in permafrost, drilling in the Beaufort Sea, under-sea transportation systems or arctic tankers. He proposed a "continuing and comprehensive program of northern science and research."**

The Science Council agrees with the theory but not with the practicality of Mr. Berger's recommendation. We agree that government must have the ability to assess industry claims independently. However, as we have indicated elsewhere in this report, Canada is a thinly spread nation. It is inconceivable, though

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*Footnote continued from p. 5-16:

2. Nelson, J.G. (Director), Renewable Resources Project, Inuit Tapirisat of Canada, July 1975.

3. Canadian Council on Rural Development, A Development Strategy for the Mid-North of Canada, Ottawa, 1976.

4. Regier, H.A., "Science for the Scattered Fisheries of the Canadian Interior", Journal of the Fisheries Research Board of Canada, 1976, 33(5).

5. Parsons, T.R., "Biological Oceanography in Canada: A Perspective and Review", Journal of the Fisheries Research Board of Canada, 1975, 32(11).

6. Hill, Dick, Science for Northerners, "Opportunities for the NWT Science Advisory Board", Paper Presented to the "Seminar on Northern Development" sponsored by the Science Council of Canada, Inuvik, NWT, June 25-27, 1976.

7. Hedlin Menzies and Associates Ltd., The Role of Canadian Control of Technology in Northern Development, An Essay for Committee on Northern Development, Science Council of Canada, October 1976.

**T. Berger, op. cit.. p. xviii

it would be desirable, for the government of Canada to replicate all industry's research. The Science Council urges rather that government develop a capacity to selectively replicate key data needed for evaluating project proposals intelligently. This will allow for spot checks as needed without unnecessary duplication. It should have been possible, for instance, for the Berger Inquiry to let out or cause to be let out contracts to fill key research gaps to NRC or another independent organisation.

This position of selective independence is reasonable only to the extent that project proponents and their parent companies are willing to bear the full costs and to take the full risks of their actions. To the extent that government is expected to provide financial guarantees, pay for social and environmental costs, or take equity in a project, it will be correspondingly important that the guardian of public interest take fuller responsibility for verifying the claims of those who have only limited liability if the research is deficient.

Science policy suggestions often reflect differing perspectives. The participants at the NATO Arctic Systems conference held in St. John's in August 1975 were predominantly concerned, for instance, with the communications, navigations, and transportation technologies needed to support resource exploration and production in the Arctic. There are many tasks to be performed in this area, starting with techniques for assessing resource potentials and engineering requirements such as remote sensing and improved geophysical and geochemical exploration techniques. For example, areas which need to be addressed, and expertise which is required, for industry to design and government to choose between pipeline and marine modes of transportation for gas from the Arctic Islands, include the following:

- Meteorology, climatology.

- Properties of upper atmosphere and magnetosphere.
- Studies of the marine circulation of the channels of the Arctic Archipelago, coupled with studies of fresh water inflow, heat inflow, and thermal pollution.
- Oceanographic studies, especially offshore Labrador and Baffin Island.
- Submarine and sub-ice hydrocarbon production techniques.
- Iceberg and sea-ice reconnaissance and forecasting.
- Communications and navigation systems.
- Physics of ice and ice bergs.
- Properties of permafrost.
- Process of terrain degradation and recovery.
- Terrain evaluation in areas where construction is planned.
- Hydrographic surveys.
- Materials engineering.
- Oil spill prevention, clean-up and contingency plans.
- Icebreaker design.
- Large mammal inventories, especially habitat requirements, harvest rates and behavioral adaptation to human intrusion.

There are other research areas which are critically important if the strategy of mixed development is to be successful. These include the following, for example:

- Studies of improved techniques and programs for renewable resource management (especially those commissioned or performed by northern peoples).
- Existing land use patterns of native people.
- Epidemiology of specific northern problems.
- Research on the social effect of communications.

- Occupational health hazards.
- Training of health and educational employees from the south in the language and culture of northern peoples and investigation of alternative means of health care delivery with higher participation by northern peoples.
- Studies of native language, culture, and social achievements.
- Comparative studies of circumpolar economic development strategies.
- Comparative studies of the applicability of "third world" strategies for economic development, including the use of "appropriate technology".*
- Waste disposal techniques.
- Housing design and construction.
- Demonstration projects using "appropriate technology".
- Assessments of the impact on development of an influx of transients and non-northerners to the North.
- Ecosystem studies on both an extensive and intensive basis, using systems analysis and other modelling techniques with a view toward understanding interrelationships between forestry management and wildlife harvesting, for example, or between mining and ambient air or water pollution. Particular emphasis should be paid to phenomena with wide variability, such as flood regime, population dynamics and other climatically dependent phenomena whose characteristics cannot be determined from short term studies.
- Hydro-meteorological research to develop information on water balances, permafrost hydrology, river-ice flow, and flooding. This is especially important in areas where hydro-electric projects are being considered.

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* E. Schumacher, Small is Beautiful, Sphere Books Ltd., ABACUS edition, London, England, 1974.

- Methods of conducting, storing, and transmitting energy for community uses, as well as for projects.
- Air pollution and water pollution characteristics and impacts.

It is within Canada's competence to improve our expertise in these and related areas of northern science significantly. In some areas knowledge exists but is not applied. Housing and waste disposal are often cited in this connection, but the problem is elsewhere as well. For instance, a relatively large and useful amount of information exists about geotechnical terrain evaluation, yet each year the same mistakes are repeated, with resultant losses in time, money, and equipment, as well as damage to the terrain. These mistakes are not made because information is inaccessible or unavailable, but because of ignorance and/or haste. In the next chapter, we refer to technology assessments as one way of ensuring that such knowledge is actually applied.

COMMUNICATIONS, COOPERATION, AND COORDINATION

Successful development is built on a sound basis of knowledge which is used efficiently and effectively. To utilize the fruits of scientific knowledge, the appropriate communication technologies and facilities must be made available to northern peoples and institutions.

By communication technologies and facilities we not only include the conventional telephone, radio and television services, but we also refer to information retrieval systems and satellites, which seem to us to have particular relevance to the needs of people living and working in the North.

Existing facilities are inadequate. The complaint is often heard in the North that telephone service is inferior to that in the South and that television programs originate exclusively in the South. Radio service receives fewer complaints, but is criticized for not providing enough programming in native languages, for not originating from outside the major centres, and for

being biased against rapid development which some northern residents feel is crucial to economic growth.

What is needed is a more effective network between various parts of the North. This network should not be limited to radio and telephone nor only to the Yukon and Northwest Territories. Its goal should be to meet the informational, educational, and entertainment needs of all northern peoples. As the introduction of the Anik satellite system suggests, communications technologies have powerful transformative possibilities, and should not be introduced without having to undergo the same type of rigorous technology assessment process advocated in Chapter Six. The Science Council believes that the experiments using the facilities of the Communications Technology Satellite are important in this regard. Assessments of the CTS projects will be more credible if they are performed by people other than those who suggested and carried out the project and who have a natural interest in seeing the project declared a success.

Of all the major service technologies applied in the North (medical, housing, waste disposal, and communications), the choice of communications technologies is the most critical. Too little is known of the ideal design changes which would best adapt communications technologies to northern environmental and social conditions. Studies should be undertaken now, before decisions are made which will commit northerners to communication technologies which are either inappropriate or inadequate to meet the needs of the strategy of mixed development for the North (See page 6-20). For instance, plans for the Anik B satellite call for four 12/14 GHz channels with the capacity for two way interactive video and audio communications in addition to the 12 regular channels on the 4/6 GHz band. Should not two of these channels be assigned to the North in such a way that access to adequate communication facilities will be

broadly available to all northern residents? This is just one possibility. With communications technologies, demonstration projects in one area may not apply in another area. Nevertheless, they may still give a good idea of the range of problems and opportunities.

Communications and Cooperation Technologies

Techniques of cooperation and information exchange must be developed among representatives of special interest groups (including native groups and environmentalists), government, industry and universities. This has both national and international dimensions.

Computer-accessed data gathering and storage systems are an essential component of modern scientific enterprises, and in this regard, there is a particular need for a Canadian northern bibliographic service. At present, the major arctic information retrieval system is U.S. based. A first step toward the establishment of a Canadian-based northern data system would be the identification of northern elements in existing Canadian scientific and technological data systems. There is also need for more cooperation at the international level on information exchange. This might enhance the possibility of using the most appropriate research whatever its origin.

In addition, there is a need for exchange and coordination at the working scientist level. The present situation needs improvement. There are relatively frequent opportunities for cooperation and contact with scientists from the United States, often aided by the Arctic Institute of North America, reflecting that the characteristics of western Alaska have a great deal in common with the Yukon and the Mackenzie Valley. But contacts with other circumpolar countries should be increased. There is also a need for a publication which surveys the Arctic literature of other nations and makes translations available. It is important that this publication deal not only with the natural sciences, but

also with economic development, native communities, and so on. The Arctic Institute of North America published a bibliography which accomplished this to a considerable extent, but it is no longer published.

National Coordination of Northern Research

The Science Council recommends that information about the results of scientific and technological activities be assembled and co-ordinated so that they are accessible and useful to northern peoples and others involved in northern development.

At the national level, several inter-university, inter-governmental, and inter-industrial committees and consortia have been established. Some of these have been effective, such as the Arctic Petroleum Operators Association. On the other hand, the Advisory Committee on Northern Development, chaired by DIAND, was by-passed by DIAND on many occasions and was used as an instrument of departmental policies on others, so that its effectiveness in a coordinating role was considerably diminished from what it should have been. The fact that some of its activities are not public knowledge has made it difficult for parliamentarians and others with an interest in the North to inform themselves about activities related to northern development as fully as they ought.

A major need is for coordination and exchange among those who fund northern research. It is not necessary that all coordination be done by government which, like any institution, has special interests to protect.

The recently constituted "Association of Canadian Universities Active in the North" is an important development that could provide the vehicle for coordinating university involvement in government-sponsored research activities. With its several subcommittees (Research, Education Policy, Relations with Northern People, International Relations, Northern Field Research) the Association has major potential as an institutional device for achieving

coordination of research.

Intra Northern Cooperation

Northern parts of the provinces have many similar problems. There is a need for a "council" of provincial and federal assemblies, composed of members from the Mid-North and Far North, to meet to discuss areas of common concern. The council should have the capacity to commission research and should have a continuing secretariat, perhaps provided by the Canadian Council on Rural Development.

Bilateral exchanges should also be encouraged. While the physical characteristics of, for instance, northern Saskatchewan and the Labrador Coast are quite different, the political and economic problems have similarities. Opportunities for exchange between the Northern Municipal Council in Saskatchewan and the Labrador Resources Advisory Council would be beneficial for both groups. This program should also encompass the needs of native groups and civil servants.

Federal Provincial Coordination of Northern Resource Projects

On past occasions the Science Council has recommended a variety of coordinating mechanisms.* Specific recommendations have included the strengthening of the Canadian Council of Resource Ministers and its secretariat (unfortunately the opposite has occurred - the CCRM has virtually ceased to function); regional resource management authorities; and in its report on energy R & D , an intergovernmental secretariat to serve the development of a national energy policy through federal-provincial Ministerial Meetings.

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* Science Council of Canada, Natural Resource Policy Issues in Canada, Report No. 19, January 1973, p. 30.

Fragmented ownership and jurisdictions within Canada have resulted in a situation where there are significant barriers to effective resource management.* Some of the problems are constitutional, while others reflect the administrative framework which has evolved in response to political requirements and pressures. As a result, jurisdictional patterns often make no sense from the point of view of rational resource use planning. Political boundaries simply do not always reflect geographically important conditions such as terrain, river flows, fish, bird, and mammal migration patterns, to mention a few. Against this background, it is especially necessary that all levels of government should have research capabilities for dealing with technical issues.

The Science Council has identified several problem areas which must be addressed with respect to the acquisition of information.

Improved communication and a coordinated data base accessible to northern residents and institutions will do much to solve the problem of secrecy which was discussed in the Northern Development Committee Discussion Paper.** It may well be that canons of proprietary information and the Official Secrets Act are used more than seems necessary. In particular, members of parliamentary committees and provincial legislative assemblies need to have better access to information (and not on a restricted or confidential basis). It is intolerable that Members of Parliament should regularly report difficulties in gaining access to technical and scientific information relevant to political decision-making. If the government required the earliest possible disclosure of industrial engineering and environmental research related to specific or likely

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* Thompson, A.R., Eddy, H.R., "Jurisdictional Problems in Natural Resource Management in Canada", Essays on Aspects of Resource Policy, Background Study No. 27, Science Council of Canada, May 1973.

**Issues 3., op. cit

project proposals, then unnecessary barriers to the flow of government sponsored technical information relevant for northern development would be removed.

Research Capacities of Legislative Bodies

The Science Council recommends that the research capacities of legislative bodies and individual legislators be systematically improved. While there has been a noticeable improvement in the quality of questioning emerging from parliamentary committees associated with northern matters (during the lifetime of this study), provincial legislatures have not uniformly fared as well. For instance, the Official Opposition in Ontario seems to be well informed on matters related to northern development. This reflects a research capability for dealing with technical issues. Other provincial opposition parties do not seem to be able to muster the same research support.

Inadequate research support to legislatures is an area which goes far beyond the confines of northern development. Among the innovations which should be considered are:

1. Providing adequate research support to federal and provincial legislative committees.
2. Providing provincial legislators with facilities such as those provided by the Parliamentary Library of the House of Commons. Unlike the procedures in the Library of Parliament, this research should be publicly available.

Some provinces, as well as the N.W.T., by establishing science policy advisory bodies, have explicitly recognized the role which knowledge plays in policy-making. One of their tasks should be to consider the processes and institutions which can aid the acquisition, dissemination and assessment of technical information.

## CHAPTER SIX - DIRECTION AND CONTROL OF DEVELOPMENT

The major challenge for the strategy of mixed development is determining the optimum choice and pacing of projects. In fact, whether or not there is a conscious strategy for northern development, the choice of which projects are done, and in what order, determines the type of change which will take place.

There are four major recommendations in this chapter:

1. The goal of technological sovereignty should guide northern development.
2. To complement technological sovereignty, there is a need for northern research, development and demonstration projects as determined by local needs.
3. In general, the Science Council endorses the Federal Guidelines for Scientific Activity in the North. It is now necessary to seek appropriate means of implementation, and to apply them to scientific activities more generally.
4. Large projects, as well as small ones, require an appropriate commitment to assess their feasibility, acceptability, and impact, both individually and in terms of their cross-impacts.

### TECHNOLOGICAL SOVEREIGNTY

The goal of technological sovereignty should guide northern development. As we have already indicated (Chap. 4), there are four major principles which should guide the selection, timing, and mode of implementation of both large and small projects. At the national level, the Science Council believes that the goal of technological sovereignty should guide pacing decisions.

There are several kinds of policy measures which can and are being used in pursuing technological sovereignty. Some are aimed at influencing the flow of information, others at influencing the rate of reinvestment, still others at influencing the corporate decision-making process. The specific means include:

1. regulation, taxation, royalties, tariffs, quotas
2. public ownership and equity participation by governments
3. patent, licensing, and freedom of information policy
4. subsidies and/or incentives for research, development, exploration and investment
5. informal and formal advisory and persuasive bodies

Below we discuss some of the initiatives which currently exist and which deal, piecemeal, with this issue. The Science Council is concerned that these initiatives are frequently implemented late in the innovation process and often do not have as their long-term goal the Canadian control of technologies relevant to resource development. Rather, there is too often a willingness to settle for "a piece of the action", and adoption of positions and policies designed to optimize short-term returns rather than the realization of long-term goals.

Policies must be deliberately coordinated to promote technological sovereignty by protecting new opportunities for Canadian enterprises and by supporting the evolutionary development of Canadian expertise in areas of importance now controlled by others. This will require a clear statement of intent and goals by government and then the careful organization and promulgation of a consistent framework of regulation, procurement policies, taxes and incentives. The aim is to stimulate private Canadian enterprise.

Crown corporations should have as part of their mandate the promotion of technological sovereignty and should be assessed and held accountable for their performance with respect to this goal.

The Role of Regulations

The use of regulatory means to promote the development of indigeneous industries of special interest and importance is widely practiced by many

nations. There is a clear recognition that only through the internal development and associated domestic control of the means of production can one shape and utilize technologies in support of broad national goals. When the control of the technologies lies elsewhere, it is inevitable that allegiance to the economic, social, industrial, and national interests and policies of another nation or nations will be seen to the detriment of the host nation.

In contrast to many other nations with comparable technological competence, Canada has been singularly flexible and compliant. Too often, policies are ad hoc or depend to too great an extent on goodwill and persuasion. While persuasion with all its limitations is important, in such matters goodwill is amiss.

A good example of a Canadian approach is the Advisory Committee on Industrial Benefits from Natural Resource Development, a subcommittee of the Advisory Committee on Northern Development. Composed of civil servants in the Department of Industry, Trade and Commerce, the objective of the Committee is to increase Canadian participation in large northern projects which have an element of federal control and/or regulation. While the Committee has no direct powers to enforce Canadian content rules where they exist, it does attempt to increase Canadian content of resource projects. It does this by meeting with the appropriate company and finding out what the latter is willing to do to maximize Canadian participation. The implied power of the government to withhold export permits or other necessary regulatory approvals gives the Committee some indirect influence.

The Committee's aims are laudable and it has to its credit some modest successes, including a role in the location of a Fluor Corp. office in Canada. It remains to be seen to what extent this relocation contributes to the development of a truly indigeneous capability to undertake such developments

from their initial concept to final commission. The Committee, nevertheless, is essentially reactive. It is not guided by a policy sufficiently strong and detailing the ways in which more Canadian participation and control should contribute to the mastery and control of technology vital to our sovereignty.

Since the opportunities before us must involve far more than a "piece of the action", the preferable course is to strive for long-term technological control. This may mean considering projects on a different scale or at a different pace than those most advantageous to non-Canadians, and balancing short-term returns with the more important long-term goals. All the opportunities for regulation through the granting of permits, licenses, grants, etc., and the control of information flow, should be consistently used as instruments in support of the broad national objectives of technological sovereignty.

In the May 1976 announcement of a Proposed Petroleum and Natural Gas Act and New Canada Oil and Gas Land Regulations by the Ministers of Energy, Mines and Resources, and Indian Affairs and Northern Development, the government explained its position as one which was designed to increase the pace of exploration activity, and to better control the pace of development and production.

> "This new legislation is designed to promote the early assessment of Canada's frontier oil and gas resources through incentives to explore, and disincentives to allow land to remain idle, and by granting the necessary authority to require a certain pace in exploration activity as a condition of holding exploration permits. This is in accordance with

the goal of self-reliance and the elements of the National Energy Strategy announced in late April".*

Could the proposed regulations not also reflect a measure of commitment to the goals of technological sovereignty, and in their application a realization of the importance of early participation by Canadian expertise and industry and its development where lacking? Control of the technologies vital to our sovereignty will continue to elude us if we fail to take such action.

The Role of Public Corporations

In the North, where risks are already high and the implications of development have far-reaching national effects, the Federal Government has a major role to play. In the Arctic Islands, Pan Arctic Oils Limited is the major operator and is 45 per cent government-owned, and official government policy has now given PetroCanada a significant northern role.

The Act establishing PetroCanada gives it exceptionally broad objectives and the appropriate powers to achieve them.** PetroCanada is at present participating in a number of frontier projects where the opportunity to develop indigeneous Canadian technologies and industry is of great importance in both the near and long-term. It is a participant in Syncrude, Polar Gas, and a proposed project to produce, gather, liquify, and ship to market, gas from the high Arctic Islands.

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* Statement of Policy: Proposed Petroleum and Natural Gas Act and New Canada Oil and Gas Land Regulations, May 1976, Energy, Mines and Resources Canada, Ottawa.

**Bill C-8, Petro-Canada Act, Statutes of Canada, Ch. 61, Vol. II, Received Royal Assent on July 30, 1975.

In these projects, PetroCanada is acting effectively as an instrument of government policy rather than as a competitor in the oil industry.

Within its broad mandate, PetroCanada should strengthen its efforts to develop similar means by which it can play a central role in effecting the direction and rate of northern development and in enhancing Canadian technological sovereignty, particularly as it pertains to the North.

The Role of Research, Development and Demonstration

Research, development and demonstration (RD&D) programs are set in place to remove uncertainties from potentially beneficial ventures so that the level of confidence pertaining to project decisions is increased. These programs are also vehicles through which industrial innovation can be stimulated in Canada. The problems of Canadian industry have been addressed in previous Science Council reports.*

RD&D programs can stimulate industrial innovation in a number of ways. In addition to tax incentives, and a supportive regulatory framework, there is the contract-out research and even the use of the purchasing powers of departments and agencies to encourage industry.

Governments can also set up special agencies to do the job. One particularly good example is the Alberta Oils Sands Technology and Research

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* cf. Science Council of Canada, Technology Transfer: Government Laboratories to Manufacturing Industry, Report No. 24, Ottawa, 1975.
Science Council of Canada, Innovation in a Cold Climate, Report No. 15, Ottawa 1971.
A.J. Cordell and J.M. Gilmour, The Role and Function of Government Laboratories and the Transfer of Technology to the Manufacturing Sector, Science Council Background Study No. 35, Ottawa, 1976.

Authority (AOSTRA), which has $100 million to spend on contracts for industrial research and pilot projects to establish the most advantageous methods of in situ extraction and production from the tar sands.

The goals of the Authority resemble the goals of the federal oil and gas regulations, as well as the goals of the government of Saskatchewan with respect to potash. In both these cases, the governments felt that the industrial pacing of development was too slow to meet the needs of the province (or nation). It was felt that by taking direct action, the pace might be increased.

The activities of AOSTRA should make a valuable contribution to developing technologies which may make the in situ extraction of the tar sands more feasible. It will do so in a manner which will give the people of Alberta a good opportunity to choose and to own those technologies most appropriate for their needs. To date, five major projects have been launched to test advanced oil recovery concepts and they are being financed on a 50/50 basis by industry and the Alberta Government. All technical know-how and patent rights will be owned by the Authority, and the licensing income will be shared with the industrial partner. By investing now in the research and development, there will be a better opportunity to control the pace of development later. The potential size of the tar sands oil reserves justifies reinvesting Alberta's royalties in this way. Research subsidies have a valuable role to play in supporting selected activities and companies which can improve northern development. The principle also applies to enterprises smaller in scale than the tar sands.

RESEARCH AND DEVELOPMENT FOR LOCAL NEEDS

In addition to the activities in support of the broad objectives of technological sovereignty, there is a need for northern research, development, and demonstration projects, as determined by local needs. The first need is for

research which attempts to define and gather data on the impact of southern governments and industrial society on northern peoples and the northern environment. Secondly, there is a need for research and demonstration projects which promote the economic and social development of northern peoples, particularly projects on a scale amenable to community control. It is important to stress that these research activities will only be effective if they are related to local needs.

Research addressed to the first need would be designed to obtain more information on physical and mental health, and the environment. Nutritional research is an example. The introduction of western style foods has had a negative impact on the dental health of most native people, and may be a contributory cause of other, now more common ailments, such as obesity.* The economic value of "country food", on the other hand, has often been underestimated or ignored by researchers.

If country food were more accurately valued in terms of its relationship to store bought substitutes, and, in addition, if its dietary use led to reduced health and social costs, its value would be high indeed. These considerations provide an example of the kind of activity needed to achieve the strategy of mixed development. In this case, pilot projects, or full-scale ones where

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*Mayhall, J.T., "Inuit culture change and oral health: a four-year study"; Titley, K.C., Mayhall, J.T., "The dental disease status of Indians resident in the Sioux Lookout zone of northern Ontario" and Draper, H.H., "A review of recent nutritional research in the arctic", Circumpolar Health, Proceedings of the Third International Symposium, Yellowknife, N.W.T., ed. Roy J. Shephard and S. Itoh, Published for Health and Welfare Canada, University of Toronto Press, 1976.

appropriate, could test various means of reestablishing native people's dependence on country foods. These projects should be evaluated in terms of the impacts on health and social costs.

The social science research necessary for the successful realization of such projects would have a different orientation from much of the present social science research, especially research with an "activist" cast. The necessary research is related to flexible life style options, and its primary orientation should be towards identification of desires and needs, and the means of achieving these. This distinction is subtle, but important.

The second area of research activities is concerned with locally controlled community development. Here, designs and appropriate technologies often exist and need only be applied or implemented. This is the case for technologies for northern housing, waste disposal, and health care delivery. Techniques of log house building, for instance, are well known, but northern native initiatives to build log houses have stalled, in part because of a CMHC requirement for logs which are larger in diameter than those normally found in the North.

Notwithstanding available technologies, work remains to be done. A few basic principles should guide the design and application of technologies which have, as a primary aim, the goal of enabling northern communities to become economically more self-sufficient, thereby giving many northern residents the opportunity to become self-supporting without leaving their community or abandoning their preferred life style. The principles are:

1. Economic development opportunities should ideally exist in the community, or within a reasonable distance, especially during the hunting and

fishing season.

2. Local materials, products, labour, and capital are preferable to imports.

3. Production methods must not make unrealistic demands, particularly with regard to organization, skills required, financing, and so on. In order to simplify the technology used, developmental work will be required in many cases which takes account of the objectives of the activity, the scale of the resources available, and the skills of the users.

Although the possibilities are enormously varied, they have not often been seriously investigated. Donald Snowden has listed, among others, the following as areas which hold promise for the coastal residents of Labrador.*

- Improving gear and shore facilities in support of the inshore fisheries.
- The utilization of species not now harvested, such as brook trout, mackerel, scallops, and herring spawning under ice.
- Development of snowmobiles, which would permit harvesting of local timber resources with less damage to machines and forest
- Development of techniques of fresh water winter fishing combined with husbanding caribou, hunting and trapping
- Local garden plots
- The berry industry

Similar lists could be developed for other northern areas. They would constitute evidence that it is possible, given the appropriate conditions and technologies, for the residents of many northern areas to establish,

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*Donald Snowden, "Appropriate Technology for the Development of the South Coast of Labrador", in Canadian Council on Rural Development, "Appropriate Technology for Development of Canada's Marginal Regions", Ottawa, 1976.

reestablish, or continue the development of a capacity for self-reliance based on the wise use of local resources in community industries built around appropriate technologies. If Canada's North is truly to develop, such developments must be encouraged.

There can be no technological fix to the maintenance of flexible life style options. Knowledge and research are a necessary condition for helping to create opportunities for life style choices. They are, however, only a means, not an end.

SCIENCE IN THE NORTH

In general, the Science Council endorses the Federal Guidelines for Scientific Activity in the North.* It is now necessary to seek appropriate means of implementation, and to apply them to scientific activities more generally.

The recently promulgated Guidelines of the Department of Indian Affairs and Northern Development are designed to increase the role of native peoples in scientific work, to increase their role in decisions on research affecting them, and to ensure that the research is well planned, relevant, and adequately communicated to those who need it. As well, they advocate that the research should progress at a steady pace "rather than on a crash basis in response to crisis demands." (See Appendix One for the full set of guidelines.) The guidelines also urge, sensibly, that observational networks aim for broad coverage, rather than depending, for convenience sake, on existing settlements and communications. Finally, the guidelines point out the important role Canada plays as host to international scientific projects and our rights to receive the data from such projects.

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* See Appendix One

Our concerns are:

1. The guidelines have a federal orientation and do not take sufficient account of the possibility that northern objectives may sometimes require different research to be undertaken than would seem necessary from a strictly national viewpoint. How about northern goals for the North, and northern objectives?

2. The guidelines recommend that the Advisory Committee on Northern Development (ACND) review federal scientific activities in the North to ensure that these activities are within their original purposes. The Science Council believes that this is properly a function of MOSST. The ACND is not in a position to evaluate programs objectively because of the departmental allegiances of its members.

Other statements have addressed the activities of individual scientists in the North. A subcommittee of the Canada/Man and Biosphere (MAB) group has issued guidelines for the conduct of scientists undertaking work in the North. As well, the native groups* and the Government of the Northwest Territories** have taken initiatives designed to enhance both the participation of northerners in research and the relevance of the research to northerners.

These moves are desirable and we hope they will also be extended to areas of provincial responsibility. Their basic thrust is to encourage collaboration and participation of northern peoples in scientific work.

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* e.g. COPE (Committee on Original People's Entitlement), Brief to Science Council Seminar, Inuvik, 1976.

**Northwest Territories, An Ordinance Respecting Scientists, 1974 and An Ordinance for the Establishment of a Science Advisory Board in the NWT, 1975. See also P. Larkin, Science and the North: an essay on aspirations, Science Forum, Vol. 9, No. 6, December 1976.

Local participation in science policy decisions must also occur more frequently. No one expects the average northern citizen to have a useful opinion about research on the aurora, or the physical circulation of the Beaufort Sea, or the likely climate on Ellesmere Island in the Jurassic period. In the absence of discernible impacts on northern communities, decisions about these kinds of research can be left to specialists. But most of the research that is needed by northern peoples is highly relevant to their lives. Where do the whitefish come from that spawn near the mouth of the Mackenzie? What are the seaward migrations of Arctic char from Pond Inlet? What determines where the caribou will go? What is a safe harvest of narwhals? Where are the best stands of timber? What kind of soils are found near Fort Smith? How can you best transplant musk oxen in the North? For these kinds of questions local knowledge is important not only for its contribution to the answers, but also for its contribution to the questions. It would make good sense to provide special research funds to a northern committee, composed half of experts and half of locals, to finance research projects of applied and locally perceived merit.

## TECHNOLOGY ASSESSMENT AND DECISION-MAKING

Projects with potentially large impacts require an appropriate commitment to assess their feasibility, acceptability, and impact.

This study began more than three years ago with a concern for the quality of decision-making as it pertains to proposals for large northern resource projects. This was a natural orientation for the Science Council. As a science policy advisory body giving public advice, the Council wished relevant environmental work to be a part of decision-making, rather than patch-up work

done after the decision to proceed had been made.* Scientists as a group tend to prefer that decisions be made with as good a factual basis as possible. The timing of the assessments, their comprehensiveness, and the subsequent monitoring and evaluation are critical.

For northern development decisions to be made, there must be some means of assessing and identifying possible conflicts, such as those between presently competing land uses, or between present and possible future land uses. These conflicts may reflect the relative advantages of extracting non-renewable resources. They also reflect conflict between the perceived needs of souther Canadians for energy or minerals versus the perceived requirements of native northerners for developing social, political, and economic self-sufficiency. These conflicts are important and the Science Council does not minimize them. However, the Science Council believes that the application of appropriate technologies and scientific research can provide information with which to resolve them and reduce some of the polarization which has occurred. In the North, as elsewhere, there is a discomforting tendency among opposing forces to ignore or distort scientific results which do not conform to pre-established expectations. This exacerbates the conflict rather than helping to resolve it.

As was pointed out in the Science Council Discussion Paper on Northern Development,** it is the function of the technology assessment system to identify, and wherever possible resolve, the scientific issues about which major actors disagree. An example of such an issue is the question of whether the pipeline construction plan of Canadian Arctic Gas has adequately explored the effects of a phenomenon such as frost heave, which might weaken or even

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* T.J.F. Lash, D.E.L. Maasland, G. Filteau, P. Larkin -"On Doing Things Differently", Issues in Canadian Science Policy, #1, p. 9-16.

**Issues 3, op. cit.

fracture the pipe.

At a less contentious level, there are only scientific and technological problems. It is the task of the project proponents to resolve specific technological problems, such as the development of proper techniques for laying pipe in channels where ice scour may occur.

It is the task of the political system as a whole to decide the most contentious question--risk acceptability. This includes, for instance, a decision on whether to take the risk of a blow-out in the Beaufort Sea, considering the relatively low probability of a blow-out in any one well, versus the major problem of how to clean up a large spill quickly enough to prevent extensive environmental damage if a blow-out did occur.

The most critical aspects of an assessment are its timing and its comprehensiveness. It is important to begin assessments of a project or series of projects early in the decision-making process. Comprehensiveness will vary with circumstances. It is the size of the potential impact, rather than the size of the project, which is critical. The costs of assessing smaller projects will often be less than larger projects. In fact, it may be argued that the same time-consuming standards of comprehensive assessment need not apply because in some instances there would not be enormously disruptive social or environmental impacts.

For this reason, the Science Council urges that there be more pilot projects and small scale demonstration projects in the North, and that the monitoring of these projects be considerably improved. Too often the lessons of one failure are hidden or the successes exaggerated, in either case for reasons of bureaucratic expediency.

The value of a technology assessment process was clearly demonstrated in the Mackenzie Valley Pipeline Inquiry. The evidence and the procedures

employed, combined with the fact that there were two (and later three) competing applications to transport gas from Alaska and the Mackenzie Delta, enhanced the quality and quantity of information about the proposal. The Inquiry had the unintended consequence of providing the National Energy Board with better prepared intervenors than it would have had if the Berger hearing had not taken place. Moreover, as a consequence of the hearings and the time they consumed, Canadian citizens and their elected representatives had a much better opportunity to appreciate the issues.

For example, there is now a wide public awareness that the choice of route for a pipeline has implications for the distribution of benefits between Canada and the United States, and that much depends on which country has how much gas for potential distribution to which markets. With a modest perception of such fundamental economic and political issues, the average citizen could at least begin to participate to the extent of judging who was likely to exaggerate this and minimize that. The actors and issues were no longer the same shade of grey.

There were, of course, many other dimensions to heighten public awareness. Placed in the context of wide concern about energy resources, the Berger Inquiry was a local issue in discussions of world energy shortages and their impact or the national economy. Alternative sources of gas, alternative methods of transporting gas, alternative sources of energy and alternative life styles were all mentioned in the debates, and while much of this discussion would have taken place in any event, the Inquiry was nevertheless a fairly conspicuous catalyst.

Perhaps the most significant impact of the Inquiry was its emphasis on the social issues. Again, the Inquiry took place at a time when many other events were shaping public concern for native peoples, but the thoroughness and patience with which the hearings were conducted established a high standard of investigation which was widely recognized and praised. Indeed, the Inquiry

enabled an articulation of the views of some groups of northerners who otherwise may not have been heard.

The intent of the Berger Commission procedures, which was to combine the social context with hard scientific evidence, is consistent with the argument of this report. Whether the Inquiry will achieve the desired balance remains to be seen. But one lesson has already emerged and is irrefutable - the future uses of science technology in the North will be much more related to the aspirations and needs of northern people.

The lessons of the Berger Commission should be a subject for detailed assessment in the not too distant future. In particular, the use of the adversary procedure for the evaluation of technical evidence, while successful in pointing out knowledge gaps, had the disadvantage that the evidence was often presented in a selective manner. Assessors should be able to go beyond the courtroom and in a sense, contract for scientific work. The normally reactive stance of regulatory bodies in Canada has not always permitted this. However, those bodies which have an independent research capacity, or the ability to contract for it, are better able to discharge their regulatory and technology assessment functions. This should be encouraged.

All government bodies contemplating a major project should carefully consider the degree to which technology assessment procedures and broad interpretation of terms of reference are applicable.

Another not yet completed technology assessment system concerns a reach of the Churchill River where the Saskatchewan Power Corporation (SPC), a provincial crown corporation, has proposed a hydro power development. After SPC had developed this engineering proposal in detail, an agreement between the federal government and the provinces of Saskatchewan and Manitoba led to an environmental and social-economic impact assessment known as the Churchill River

Study (CRS). Even before CRS commenced its work, the province of Saskatchewan stated its intention to follow the study by the Churchill River Inquiry. At present, CRS has completed its task and a Board of Inquiry of four members has been appointed. Its initial meetings will obtain information to guide the preparation of more formal Hearings. The Board's report is expected in 1978. It is to contain a recommendation to the Saskatchewan government on whether to proceed on the SPC proposal, not to proceed, or to proceed with certain safeguards.

The Mackenzie Valley Pipeline Inquiry and the Churchill River Inquiry differ in terms of the scale of the proposed developments and their technical and scientific studies. In addition, there are some notable differences in the timing and separation of study and inquiry, and the involvement of intervenors in various phases of the assessments. One component of the CRS was a public participation program which it is now conceded was only partly successful.* Further contributions are being invited from the public during the inquiry phase of the total assessment of Churchill River development plans. It is hoped that such further involvement, after intervenors have been provided with financial aid to prepare critiques of the study, will lead to a balance in the expression of local interests and those of the Saskatchewan public as a whole. It is to be hoped that the participants in the Berger Commission will recommend how these processes can continue to be improved.

Areas Requiring Further Assessment

In order best to direct and control development, assessments should become an integral part of the decision-making process. They should not be allowed to become a validation for decisions already taken.

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* Churchill River Study, Synthesis, Saskatoon 1976, p. 136.

Some areas related to the North require assessment:

1. An examination of alternative transportation and production methods for gas from the Arctic Islands. In a Science Council seminar held in February 1977,* the option of transporting gas from the Arctic by Arctic Class LNG tankers received support. The Science Council believes that LNG tankers may afford advantages in terms of pacing and the potential for addressing regional imbalances. It may be also an ideal vehicle for Canadian export markets, reserving Alberta supplies for the domestic market. While this approach appears to be technically feasible, its safety and its economics remain to be assessed. Although the cost of the gas would be so high as to probably preclude large royalty or tax payments, an adequate tradeoff might be achieved in terms of promoting a Canadian capability in LNG and shipping technologies. This option should be seriously examined.

2. An assessment of commuting to northern mines by air. There is now enough experience to begin drawing some comparative conclusions.

3. An assessment of the effect of telecommunications and television upon the North.

4. An assessment of alternative means of community development which emphasize renewable resources. This could be combined with an assessment of the feasibility of transferring technology and knowledge to and from less developed countries.

5. A comprehensive review of the specific technologies relevant to the North which should be supported by an analysis of the rates of development most

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*Proceedings of the Seminar on Natural Gas From the Arctic by Marine Mode: A Preliminary Assessment, 21-23 Feb., 1977, Sponsored by Science Council of Canada and the Atlantic Provinces Economic Council.

advantageous to achieving Canadian technological sovereignty.

These are technology assessments relating specifically to the North. However, similar efforts will be needed in the south, particulary with respect to changing energy production technologies and with respect to information, computer, and communications technologies. These southern assessments, however, should take explicit cognizance of the North and should not assume that it is merely an extension of the South. With this kind of anticipation, Canada should be able to make good use of existing and developing areas of scientific knowledge and technological expertise for the benefit of northern peoples and all of Canada.

## Appendix One

### Guidelines for Federal Scientific Activities in Canada's North

"1. In conducting scientific activities in the North, the native poeple must be encouraged to participate to the greatest extent possible. In scientific activities related to the people, this involvement is essential in nearly every case if the research is to be meaningful and of maximum benefit to the northern people. Every effort should be made to provide opportunities for the native people to become involved in research programs and in the uses of science and technology."

"2. In research affecting the native people, there should be prior consultation leading to informed agreement, participation in the conduct of the research itself, and feed-back of results to northern communities concerned. It is the inhabitant's perception of his environment that influences his decisions. His perception of the environment, therefore, as well as its physical properties, is an important element of research programs."

"3. Scientific activities sponsored or supported by Federal or Territorial governments should be treated as tools or services to help in the attainment of the national goals for the North. They are not ends in themselves and can only be justified if they support one or more national objectives."

"4. It is essential that in northern science programs of a multi-disciplinary nature, all relevant sources of expertise are involved in the planning and implementation phases and in the analysis of results."

"5. In accordance with the government policy, scientists from the academic community and industry should be involved to the maximum extent practicable in

government-sponsored or supported scientific activities. Wherever appropriate, the scientific programs should be carried out "by contract" with universities, non-government scientific institutions, industry, or individuals."

"6. Every effort should be made to ensure that the scientific concerns are taken fully into account in the design and phasing of northern programs. Where overriding considerations force the introduction of such programs before adequate scientific assessment is possible, the promoters should be made aware of any known deficiencies in scientific knowledge, and the implications thereof."

"7. In the design and implementation of programs, provision should be made for scientific evaluation of progress in relation to objectives, and to assess impacts and effects of program activities in order to undertake any necessary adjustments."

"8. To ensure that the lessons of experience and the results of research already completed are recorded and available for use, and to guard against repetition of research, all useful scientific and technical information acquired from programs should be adequately reported and fed into the appropriate scientific information services".

"9. All scientific programs sponsored or supported by the Federal or Territorial governments should be reviewed at regular intervals by the Advisory Committee on Northern Development through the Committee on Science and Technology to ensure that activities remain in keeping with the original purposes of the studies and their objectives. The scientific activities undertaken to meet defined needs must remain the responsibility of the accountable department or agency".

"10. The amount of effort which the Federal Government devotes to increasing and broadening its information base in northern science should take

into account estimated future demands of northern development. As far as possible, government research in the North should progress at a steady pace rather than on a crash basis in response to crisis demands."

"11. The design of Canada's northern observational networks should be the object of careful study, in order that they yield the most useful and general data, especially in relation to variations of site and habitat. Present networks often emphasize cheap operation because of existing settlements and communications, rather than good sampling principles."

"12. With Canadian sovereignty extending over such a large northern region which contains many features of special scientific interest, it is important that Canada should play a significant role in international arctic research. From the government's point of view, the emphasis should be on programs aimed at the achievement of Canadian objectives; however, there will be occasions when the international scientific community wishes to pursue research projects in Canada which do not rate as priority items for the Federal and Territorial governments. In such cases, Canada not only has some obligation to assist them but may also stand to gain from the contribution made to the pool of international knowledge and the leverage which such co-operative action provides in obtaining reciprocal information of direct value to Canada from other countries."

"13. Where the Federal Government initiates international co-operative scientific activities in the Canadian North, the following principles should apply:

a) the Canadian contribution should be defined in terms of Canadian objectives;

b) the leadership in co-ordinating such activities in Canada and their effective control should be provided by Canada;

c) Canada should receive all data and all analytical results".

"14. Where the initiative for co-operative international programs comes from other countries and the objectives are not priority items for Canada, the following principles should apply:

a) government logistic support of international scientific programs should not be considered a substitute for scientific involvement;

b) the need for the program and the reason for conducting it in Canada should be stated to the satisfaction of Canadian authorities;

c) there should be Canadian scientific participation in any significant scientific investigation in the Canadian North;

d) non-government sources, primarily universities and scientific institutions, should be invited to participate;

e) Canada should receive all data and all analytical results."*

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* Department of Indian Affairs and Northern Development, Guidelines for Frederal Scientific Activities in Canada's North, Ottawa, 1977.